AGRICULTURAL ENGINEERING

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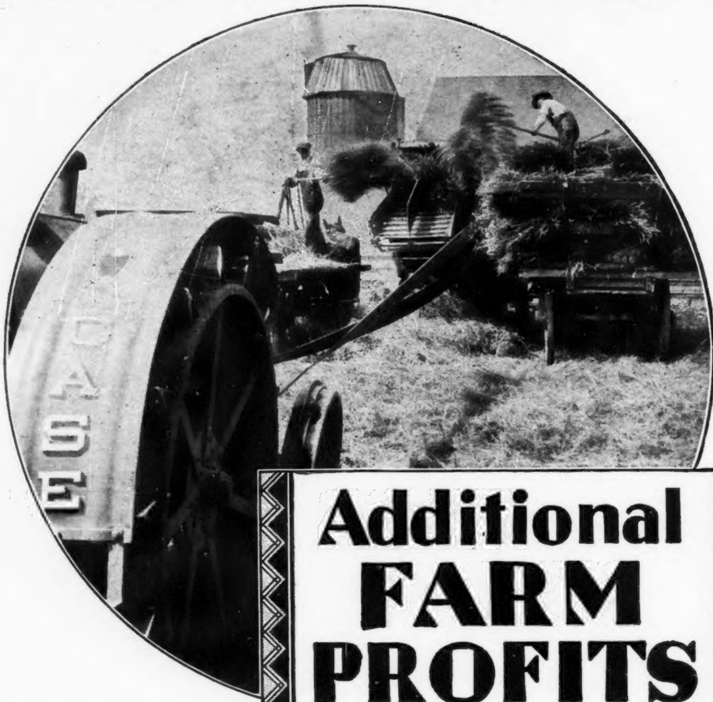
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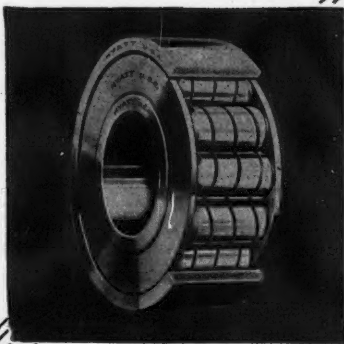

AGRICULTURAL ENGINEERING

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Recent Progress in Agricultural Engineering[1]

By W. G. Kaiser[2]

IT AFFORDS me great pleasure to have this opportunity to review some of the past year's accomplishments of the American Society of Agricultural Engineers. This has been a period marked by continuous growth in the prestige and field of usefulness of agricultural engineering in rendering valuable service to agriculture. Our membership ranks are being constantly strengthened in numbers and in breadth of experience. Under the able direction of our secretary-treasurer, the Society has remained solvent despite a continually expanding program of activities. The excellence of our journal "Agricultural Engineering" has been maintained and enhanced and its influence is being felt in an ever widening circle. Approximately 60 per cent of the Society's income is a result of profits from the journal, which weathered the financial crash last fall without serious loss of revenue from advertising.

W. G. Kaiser

In recounting the activities of the society, a retiring president is likely to find himself in an embarrassing position. If he speaks of the past, his remarks may sound boastful, especially if he speaks frankly of the affairs of the society which are close to his heart. It he makes recommendations for the future, he may be considered presumptuous. However that may be, several of our groups have made such noteworthy progress that I cannot refrain from mentioning some of their achievements.

The high quality of the work of our technical divisions, each with its several committees, has again demonstrated the inherent soundness of this plan of operation. All divisions have been unusually active and each division chairman deserves our deepest gratitude. The work of the technical divisions is particularly commendable in that they are directing their energies toward a solution of those problems which concern agriculture of today and tomorrow

I wish to speak first of the advancement in agricultural engineering education. Perhaps the greatest single handicap in the development of the science and application of agricultural engineering is the dearth of trained men in all the three major branches—research, extension and teaching. Sensing the need for a greater number of competent agricultural engineers, the College Division has set out to correct this situation and has made notable progress. Under its guidance a school of intensive training for extension workers in agricultural engineering was held at the University of Illinois, June 11 to June 14, inclusive. Another school designed to improve teaching methods is to be conducted at Ames, Iowa, in 1931, in connection with the twenty-fifth anniversary meeting of the Society. An outline of the course is now being prepared.

At the meeting of the Advisory Committee of the College Division which was held in Washington, D. C., in April, improvement in agricultural engineering instruction was designated as the major activity of the division in 1930-1931. This activity should have far reaching results in advancing the cause of agricultural engineering.

The College Division is undertaking another line of work which should receive the hearty approval and ready backing of every member—the formulation of a program to establish agricultural engineering on the same high professional plane as other branches of engineering, particularly in the curricula of land grant colleges. While some of the deans of engineering are actively sympathetic to agricultural engineering, others are passive or hostile. The College Division's program, therefore, is directed to support the former rather than to combat the latter. Agricultural engineering has attained a stage of development where it does not need to be on the defensive. In the words of E. R. Jones, chairman of the Division, "aggressive progress is the order of the day."

For a number of years, members of the Society who are especially zealous for the proper recognition of agricultural engineering and particularly those who employ agricultural engineers have realized how weak and inffective is the average candidate's application for a position. Apparently he is unable to sell his services for anything approaching their real value and he seems utterly helpless in showing his prospective employer how his experience and training qualify him for the job. The College Division has made a careful study of this important problem and has prepared a general course of procedure for the candidate's guidance in applying for a position.

FARM POWER AND MACHINERY

Changes in agricultural methods, particularly with reference to the development and utilization of power and machinery for increasing farm efficiency and reducing production costs are without precedent in the annals of agricultural progress. Illustrative of the readjustment which is occurring in farming methods is the experience of R. P. McCormick of Pocahontas, Iowa, described in the February 15 issue of "Wallace's Farmer," under the heading "Power Farming as a Means of Reducing Cost." This article explains methods employed by Mr. McCormick in raising 230 acres of corn, yielding 50 bushels per acre, with but 2.5 hours of man labor per acre up to harvesting. Picking and cribbing required 1.1 hours making a total

[1]The annual address of the president of the American Society of Agricultural Engineers at the 24th annual meeting of the Society at Moline, Illinois, 1930.

[2]Agricultural engineer and assistant manager, cement products bureau, Portland Cement Association. Mem. A.S.A.E.

of only 3.6 hours of labor per acre. This remarkable low labor cost was made possible by the use of modern equipment including a tractor, a four-row planter, a four-row cultivator, and a mechanical picker. This equipment enabled Mr. McCormick to sell eleven horses and saved him $1200 in wages to hired men.

Figures are available showing that approximately 300 man-hours of labor are required to produce and harvest an acre of corn by hand methods exclusively. Several years ago a committee of this Society made a detailed study of the various items entering into the cost of producing several farm crops—cotton, oats, hay, rice and corn. The findings of this committee, reported in the 1927 transactions, show a labor item varying from 12.8 man-hours per acre for raising corn in Illinois, to 41.8 man-hours in New York state. A noteworthy fact brought out in these studies is that decreases in cost of labor have not caused increases in the cost of power and machinery.

While Mr. McCormick's achievement—3.6 man-hours per acre—is a rather striking example of results obtained by the application of agricultural engineering methods in corn production, it is indicative of the present trend in agriculture. Similar economies are being effected in the production of cotton, wheat, potatoes and other crops by the substitution of mechanical power for horse power and manual labor.

Great changes of the kind mentioned affect the entire social and industrial structure of the nation. The feed which would have been consumed by the eleven horses, replaced by mechanical power, is moved into market channels. The two hired men whose services were no longer needed were forced to seek employment elswhere, perhaps were obliged to join the ranks of industrial workers in our cities, requiring some social adjustments in those places.

The shifting of population from country to city continues. From a farm population of 31 million in 1920 there has been a decrease to twenty-seven and one half million at the beginning of 1929—an average annual loss of 400,000. This movement is occurring without any organized scheme of transfer. The inexorable law of economics makes it mandatory and it is causing much distress although fundamentally it is a constructive phase and is interpreted as a symptom of better economic conditions. The per capita income is increased as there are fewer farm people to share the total.

Despite these necessary social adjustments, many factors indicate that the sound economical solution of farm problems lies in the direction of lowering production costs. This has been true in the solution of the problems in other industries. Many farmers like Mr. McCormick realize this situation, and are taking steps to reduce operating costs to a minimum. The low-cost producer will continue to farm at a profit whereas the high-cost producer will be forced into some other field. Farmers are in severe competition with each other and success is possible only for those who manage their farming enterprise on an efficient basis which is another way of saying low-cost production.

To keep abreast of this development in agriculture and to lend helpful guidance in this readjustment has furnished incentive for the splendid accomplishments of the Power and Machinery Division. The symposium on the general-purpose tractor presented at the meeting in December, was an outstanding contribution to our fund of practical knowledge on tractor operation. The row-crop management studies which are to be discussed here is further evidence of the close application of this division's activities to present day agricultural problems. It is highly appropriate that we meet in this great farm machinery manufacturing center at a time when the utilization of power and machinery is exerting such a tremendous influence for increased efficiency in the industry of agriculture.

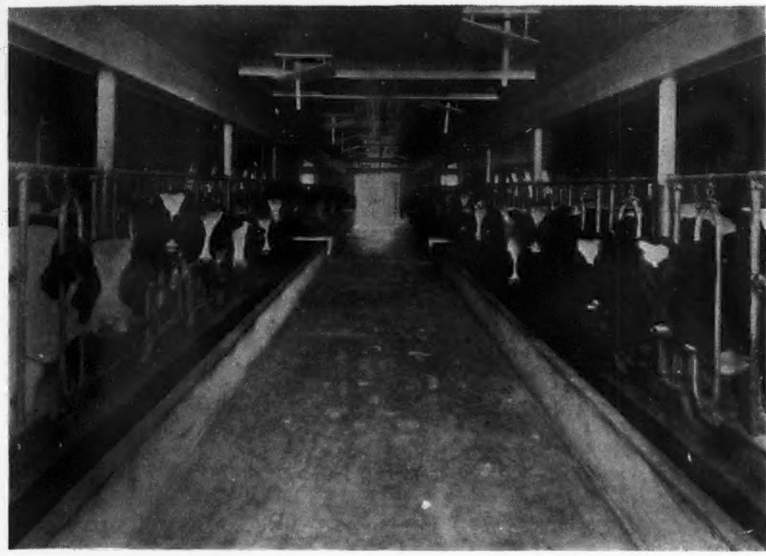
RURAL ELECTRIFICATION

Approximately one million farm homes now enjoy the benefits of electricity, either from central plants or from individual farm plants. In the period from 1924 to 1929, the number of farms receiving "high line" service increased from 175,000 to over 500,000. This tells but part of the story of the increasing use of electricity on the farm as the consumption per farm is constantly growing. The Rural Lines Committee of the Wisconsin Utility Association reports an average consumption of 16 kilowatt-hours per farm per month in 1923. In 1928 the average consumption of these farms had risen to 50 kilowatt-hours per month. One power company in Alabama with 70 per cent farmer patrons reports an average consumption of 32 kilowatt-hours per month in 1924 and 72 kilowatt- hours in 1928. Other power companies also report substantial increases in kilowatt-hour consumption.

The opinion has often been expressed that the greatest value to be expected from rural electrification is in the improved living conditions which it brings into farm homes by removing much of the drudgery of labor and affording the farm family greater opportunity for the enjoyment of the things that add to the zest of living. In addition to these desirable results which are difficult to evaluate, new applications disclose numerous tangible economic advantages of equal or possibly greater value.

Increasing use of electrical energy is introducing many

Four-row tractor planting and cultivating equipment is an important factor in reducing corn production costs



Figuring depreciation and obsolescence on farm structures at ten per cent, it is costing American farmers over a billion dollars a year for ordinary replacements and repairs. What our farmers pay in terms of reduced income for inadequate shelter or for lost time and labor because of inconveniently arranged build-is not measurable but is considerable, perhaps another billion dollars. Notwithstanding this vast annual expenditure the great majority of the country's farms are equipped at present with buildings that inadequately meet modern demands for efficient operation

problems requiring solution. These problems cover practically every branch of agricultural activity, necessitating the broadest contacts in working toward their solution. Noteworthy progress has been made by the Rural Electric Division in securing the assistance of investigators in the animal husbandry, dairy husbandry and poultry husbandry fields, where extensive studies are being made involving the utilization of electrical energy in the processing and preservation of food products. A two-day meeting of the Division in December attracted a record attendance and can be taken as an additional manifestation of the growing interest in rural electrification.

RECLAMATION

The Land Reclamation Division, the first technical unit to be organized, has made unusual progress in the course of the year. A program of work which will require several years to complete was outlined at a meeting of the Executive Committee of the Division, which met at Sioux City, Iowa, in September at the call of the Division chairman.

A two-day meeting, arranged by the Land Reclamation Division in Kansas City, December 30 and 31, attracted a total attendance of more than 100, despite the fact that it occurred during the holidays. A program covering timely matters in the major fields of soil erosion control, drainage, irrigation, and land clearing was given. Reclamation engineers of national prominence made outstanding contributions to the program and assisted materially in making the meeting one of the most successful in the history of the Division. No one can read the address given by Dr. Elwood Mead on that occasion without obtaining a new insight and a new respect for land reclamation as it affects federal irrigation developments. He completely dispels any misunderstanding to the effect that speculation is an active instrument in carrying out federal projects. He mentions the safeguards which are provided to prevent the entry of speculation. He also cites a number of projects to demonstrate the economic justification for land reclamation activities. This is impressively shown in one of Dr. Mead's introductory statements which I shall quote.

"The works already built have cost $186,000,000. The benefits from much of the expenditure have not yet been realized, because the works are not completed and the farms are not all cultivated, but even in this unfinished condition, the crops grown last year were worth $143,573,000. When these works are completed and the land all cultivated, the yearly value of the crops will equal the entire cost of the works. No greater national benefits were ever produced by a similar expenditure."

The keynote of the Kansas City meeting and of the planned future activities of the Division is expressed in the proposed plank on land reclamation submitted for the Society's proposed program: "Whereas, land reclamation, as advocated by the American Society of Agricultural Engineers, involves putting agricultural land to the best use in which it will render the largest possible benefits to both owner and the general public—whether it be for producing crops or furnishing recreation—and increasing the benefits to be obtained by the proper use of that land to the highest point commensurate with the cost involved, the Society therefore favors all forms of land reclamation consistent with the foregoing conception."

STRUCTURES

Farm buildings represent an enormous investment. There are approximately twelve billion dollars invested in farm buildings in the United States, according to the 1925 census. This is more than twelve times the value of an average wheat crop, about eight times the value of one cotton crop, and exceeds by four billion dollars the value of all livestock and livestock products for one year.

A modern farm building represents a large outlay in cash and, once built, may stand for generations. It is imperative, therefore, that it be designed and constructed to satisfy the purpose for which it was intended and to do this with the greatest economy. Many of the state agricultural colleges are rendering a valuable service to farmers in offering farm building plans on which some study has been given as to "use requirements." A number of building equipment and material concerns also offer a limited amount of help in farm building planning and construction. Many of the plans are creditable, others are accidental or are based on the preferences or prejudices of the individual who designed them rather than on a study of the "use requirements." It is not surprising then that bordering states, having practically identical climatic conditions and "use requirements," should recommend radically different plans for buildings to serve identical purposes. The trouble lies in the fact that there are practically no fundamental data on which to base the planning of farm buildings. Until such data are available

there can be no general agreement among farm building designers. In the meantime the farmer will continue to pay the bills.

To secure necessary fundamental basic data the division of agricultural engineering of the United States Department of Agriculture is undertaking a national survey of farm structures needs with the object of stimulating research agencies to see the problems and to coordinate their efforts toward solving them. It is hoped that this survey, which was made upon resolution of the Structures Division, will provide the machinery for carrying on adequate and sustained research work in farm structures by the properly constituted public agencies.

While this survey is under way a committee has been working out a set of tentative standards of "use requirements" for dairy stables. Data received from 500 leading dairymen throughout the country are being studied. A two-day meeting of the Structures Division in Chicago last December was well attended.

SECTION MEETINGS

Living up to their reputation of being a society of hard workers, individually and collectively, our sectional groups have been unusually active. An outstanding example of such industry is the work of the Pacific Coast Section. Organized in San Francisco in 1922, this section has held regular meetings annually and, since 1928, three technical meetings and one business meeting each year. There was a meeting in Oakland, California, in November in conjunction with the Ninth Annual Pacific Slope Dairy Show. Papers presented related to special engineering problems in the dairy industry. A mid-winter meeting at Davis with an attendance of fifty was devoted to subjects relating to tillage and soil moisture. The annual business meeting of the section was held at this time. Corvallis, Oregon, was the location of the third technical meeting, held in May. Farm power and machinery, tillage, lumbering and reclamation received special attention. Total membership for this section now numbers ninety-six covering a territory ranging from Mexico to Alaska.

The North Atlantic Section held its meeting at Amherst, Massachusetts, October 17, 18 and 19. The registered attendance was 111. This section is planning comprehensively for its next meeting, which is to held in Rochester. Organized in 1924, this group now has a membership of 214.

The Southern and Southwestern Sections held a joint meeting at Jackson, Mississippi, in February in conjunction with a meeting of the Southern Agricultural Workers Association. Terracing, cotton ginning, cotton production, power farming and other subjects concerning southern agricultural conditions were featured, again emphasizing the value of regional meetings for concentrating on matters of local application.

DAIRY ENGINEERING

The Committee on Dairy Engineering showed further evidence of its aggressiveness by sponsoring a dairy engineering meeting in conjunction with the National Dairy Industries Exposition in Toronto last October. Special attention was given to all phases of engineering as it relates to the dairy industry.

INTERNATIONAL RECOGNITION

A great deal of attention is being paid to the application of engineering to agriculture in European countries. The demand for American tractors and power equipment is establishing new export records for these commodities. Apparently the transition from manual labor and oxen power to mechanical power is literally occurring over night, completely hurdling the horse power epoch which lasted approximately seventy years in this country.

Further evidence of the international recognition that is being accorded agricultural engineering is indicated by the International Congress of Agricultural Engineering which is to be held in Liege, Belgium, in August. One of our members, H. B. Josephson, Agricultural Engineering Department, Pennsylvania State College, will represent the Society. You are all acquainted with the great honor and recognition which was accorded agricultural engineering at the World Engineering Congress in Tokio last October. The paper, "Engineering Applied to Agriculture," presented by our representative, H. B. Walker, on that occasion is a splendid analysis of the present trend in engineering as applied to the agricultural field.

RECOMMENDATIONS

Mention was made that the Society's finances are on a sound basis. We have remained solvent because our Secretary apparently is not bound by the usual limitations of human endurance. Frankly, our secretary's office is seriously undermanned and no way has been found to relieve it of its numerous responsibilities. We should find funds for the employment of another assistant. The logical sources of revenue are increased membership and increased advertising space in our journal. Although we now have an advertising representative, the most certain methods of securing new accounts is through personal work of individual members. Several members have done splendid work in this field. More work by more members is needed.

The by-laws of our Society are in need of revision, especially with reference to the administration of Society affairs. The chairmen of the different technical divisions are carrying an enormous burden of responsibility and means should be found whereby they may be permitted to participate in the deliberations of the council. Giving division chairmen the status of vice-president has been suggested.

Despite our reputation as a hard working group there are still many members who have not found an opportunity to take prominent part in the Society's activities. Special attention should be devoted to members newly inducted into our organization. There is no substitute for work in creating and holding interest in agricultural engineering. To this end I would suggest that each new member be asked to designate his preference for committee assignments.

An engineer has always been a modest fellow and this appears to be particularly true of the agricultural engineer. As a group we have been extremely conservative in giving publicity to matters relating to our profession. The many excellent papers presented at our different meetings should receive much wider distribution.

From time to time we have concerned ourselves with problems involving farm management. Here is a field which should receive greater attention. The increasing use of farm power and machinery and the increasing demand for trained farm operators is placing a premium on farm management. Present indications are that this group offers one of our most promising fields for drawing membership in the future.

Finally, I would like to ask all members to redouble their efforts for the advancement of agricultural engineering. In this organization there is provided a comradeship in finding the best ways to develop the knowledge of agricultural engineering and in determining the most effective means of distributing that knowledge.

Frame Building Design Revolutionized

By Frank P. Cartwright[1]

RECENTLY completed tests at the Forest Products Laboratory of the U. S. Department of Agriculture at Madison, Wisconsin, answer many long-standing questions about design of light-framed buildings and show how vastly to increase both strength and stiffness in comparison with current practice.

For years builders have been told that diagonal sheathing makes a much stronger and more rigid frame house than horizontal sheathing. No one could say what the difference was, whether it justified the additional expense or whether the weakening influence of windows and doors in the wall offset the benefits of diagonal sheathing. Are diagonal strips, let in to the studs, better or poorer bracing than two-by-four corner braces cut in between studs, or herringbone bridging at half story heights? Do three nails in each board make a wall stronger and more rigid than two nails?

These and many other questions must have occurred to thousands of master carpenters, builders, architects and engineers charged with producing a strong, rigid and permanent frame structure. They were given point by tornadoes and hurricanes which in the last few years alone have wrecked thousands of buildings of both frame and masonry construction, and by earthquake insurance rates which in some parts of the country far exceed those for fire.

[1]Chief engineer, National Lumber Manufacturers Association. Mem. A.S.A.E.

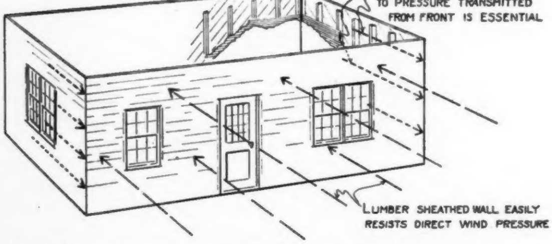


Fig. 1. Graphic representation of wall resistance to end thrust

Definite answers to these questions are given by a series of tests just completed by the U. S. Forest Products Laboratory. Prefacing its work by personal investigations in a number of storm-damaged areas, the Laboratory decided that the walls contribute most to the strength and rigidity of a building as a whole. The government engineers determined also that typical lumber-framed and sheathed walls are strong enough to resist any pressure likely to be caused by wind blowing directly against them. Wall resistance to end thrust, caused when the pressure against the front is transmitted to the side walls, is a more critical point. (Fig. 1).

With this in mind, the Laboratory built and subjected to end thrust nearly fifty frame walls of full story height (8 and 9 feet), and long enough (12 and 14 feet) to show how a real wall would act under extreme conditions. These walls were framed with two-by-fours at the usual 16-inch spacing; the sole plate was bolted to a fixed base and pressure was applied horizontally at the top plate in the plane of the wall surface. End posts, corresponding to the corner posts of a house, were built up in the usual way with three two-by-fours (Fig. 2).

Both the rigidity of the walls, as shown by the end thrust necessary to cause a given movement of the end posts from their upright position, and the strength, as evidenced by the end thrust necessary to cause failure of the whole panel, were measured. The results given hereafter are in pounds, but are far better understood by using the average strength and stiffness of a double-nailed horizontally sheathed panel as a basis. Thus, if we

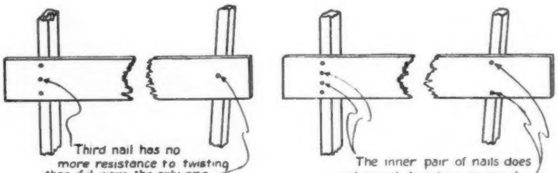


Fig. 3. A graphic representation of the effect of nailing to resist twisting

Fig. 2 (Left) Panel set up for test. The stirrup at the lower righthand corner prevents the sole plate from moving. End thrust is applied at the upper left-hand corner, in the plane of the panel. Fig. 4. (Right) Panel with "herringbone" bracing. Little added stiffness due to bracing, and fire-stopping effect much inferior to that of similar blocking at story lines

Table I. Results of Tests of Panels Without Window or Door Openings

Panel No.	Size of panel, height by length: Feet	Inches	Feet	Inches	Description of panel. Panel frames consisted of 2-by-4-inch upper and lower plates, vertical studs spaced 16 inches, and triple end posts	Stiffness factor	Load, pounds	Strength factor	Remarks
2A	9		by 14		8-inch horizontal sheathing, two 8d nails, no braces)				
19	7	4	by 12	1 5/8	" " " " " " " " ")	1.0	2,588	1.0	No. 20 vibrated 80,000 cycles
20	7	4	by 12	1 5/8	" " " " " " " " ")				
33	9		by 14		" " " " " " " " ")				
5	9		by 14		8-inch diagonal sheathing, two 8d nails, no braces, boards in tension	4.2	---	over 8	Test stopped at 20,000-pound load
26	7	4	by 12	1 5/8	" " " " " " " " " " " " "	4.3	17,100	6.6	
31	9		by 14		" " " " " " " " " " " " "	2.8	---	over 8	Test stopped at 20,000-pound load
8A	9		by 14		" " " " " " " " " " " compression	7.3	20,100	7.9	
4	9		by 14		8-inch horizontal sheathing, two 8d nails, herringbone or bridge 2 by 4-inch braces	1.3	2,800	1.1	
3A	9		by 14		" " " " " " " , cut-in 2 by 4-inch braces	1.6	3,700	1.4	
30	9		by 14		" " " " " " " , let-in 1 by 4-inch braces, first arrangement	2.6	9,250	3.6	
34	9		by 14		" " " " " " " , " " " " " " " second arrangement	4.2	9,000	3.5	
2B	9		by 14		8-inch horizontal sheathing, three 8d nails, no braces	1.0	2,300	0.9	
2C	9		by 14		" " " " , four " " " "	1.4	3,550	1.4	
6A	9		by 14		8-inch diagonal sheathing, three 8d nails, no braces, boards in tension	5.2	---	Over 8	Test stopped at 20,000-pound load
6B	9		by 14		" " " " four 8d " " " " " "	7.5	---	Over 8	" " " " " "
28	9		by 14		8-inch horizontal sheathing, two 10d nails, no braces	1.5	3,500	1.4	
36	9		by 14		" " " " two 12d nails, " "	1.3	2,800	1.1	
32	9		by 14		8-inch diagonal sheathing, two 10d nails, no braces, boards in tension	5.1	---	Over 8	Test stopped at 20,000-pound load
27	9		by 14		6-inch horizontal sheathing, two 8d nails, end and side matched, no braces	1.0	2,550	1.0	
11	9		by 14		Plaster on wood lath, no sheathing	7.2	11,400	4.4	First plaster crack at 10,800 pounds
13&24	9		by 14		" " " " , 8-inch horizontal sheathing, two 8d nails, no braces	7.9	14,500	5.6	" " " " 9,900 "
14	9		by 14		" " " " , 8-inch diagonal sheathing, two 8d nails, no braces	9.2	20,300	7.8	" " " " 12,200 "
25	9		by 14		" " " " , studs and horizontal sheathing, green lumber then seasoned one month	6.0	12,700	4.9	" " " " 8,200 "
17	9		by 14		8-inch horizontal green sheathing, two 8d nails, no braces, panel seasoned one month	0.5	1,700	0.7	
21	7	4	by 12	1 5/8	" " " " " " " " " " " " " " "	0.7	1,800	0.7	Vibrated one million cycles
18	9		by 14		" " diagonal " " " " " " " " " " " "	1.7	---	---	
22	7	4	by 12	1 5/8	" " " " " " " " " " " " " " "	1.7	---	---	
30	9		by 14		8-inch horizontal sheathing, two 8d nails, no braces, alternate sunshine and rain one month	0.7	2,175	0.8	

Table II. Results of Tests of Panels With Window and Door Openings

Panel No.	Size of panel, height by length: Feet	Inches	Feet	Inches	Openings	Description of panel. Panel frames consisted of 2-by-4-inch upper and lower plates, vertical studs spaced 16 inches, and triple end posts	Stiffness factor	Load, pounds	Strength factor	Remarks
7A	9		by 14		window	8-inch horizontal sheathing, 1 by 4-inch let-in braces	3.0	6,500	2.5	
8A	9		by 14		"	" " diagonal sheathing, no braces, boards in tension	3.1	13,000	5.0	
10A	9		by 14		window and door	" " horizontal sheathing, no braces	0.7	2,100	0.8	
8B	9		by 14		" " "	" " diagonal sheathing, no braces, boards in tension	1.4	10,240	4.0	
9C	9		by 14		" " "	" " " " " " " " "	1.4	10,150	3.9	
8C	9		by 14		" " "	" " " " " " " " compression	0.8	3,250	1.3	
9B	9		by 14		" " "	" " " " " " " " "	1.2	3,400	1.3	
7B	9		by 14		" " "	" " horizontal sheathing, 1 by 4-inch let-in braces	1.5	5,650	2.2	
10B	9		by 14		" " "	" " horizontal sheathing, no braces, 6-inch bevel siding	1.1	3,400	1.3	
10C	9		by 14		" " "	" " diagonal sheathing, boards in compression, 6-inch bevel siding	2.0	8,500	3.3	
29	9		by 14		" " "	" " " " " " tension, 6-inch bevel siding	3.3	13,900	5.4	
35	9		by 14		" " "	" " horizontal " , 1 by 4-inch let-in braces, 6-inch bevel siding	2.7	8,680	3.4	
12	9		by 14		" " "	Plaster on wood lath, no sheathing	2.3	4,200	1.8	First plaster crack at 1,300 pounds
15	9		by 14		" " "	" " " " , 8-inch horizontal sheathing, no braces	2.4	5,800	2.2	" " " " 800 "
16	9		by 14		" " "	" " " " , 8-inch diagonal sheathing, no braces	2.8	11,300	4.4	" " " " 800 "
23	9		by 14		" " "	" " " " , " " horizontal sheathing, 1 by 4-inch let-in braces	4.1	9,360	3.6	" " " " 1,800 "

take as 1 the strength of the horizontally sheathed panel with two nails in each board at each stud, the strength of a diagonally sheathed panel will be about 8, or eight times as much. If the stiffness of the horizontally sheathed panel is also taken as 1, that of the diagonally sheathed panel with the boards in compression is about 7 (Tables I and II).

The tests covered the following principal factors affecting strength and rigidity of light framing.

1. Frequency of nailing
2. Size of nails
3. Inclination of sheathing
4. Types of bracing
5. End matching
6. Seasoning of lumber
7. Effect of window and door openings
8. Effect of lath and plaster
9. Effect of vibration.

Frequency of Nailing. Three nails per stud in horizontal sheathing boards do not increase the wall stiffness appreciably, since the middle nail of the three is about at the center of the resistance couple set up by the outside nails. It acts, in other words, just as though it was the only nail in the board.

Four nails per stud in 1-by-8-inch horizontal sheathing increase the strength and stiffness about 40 per cent. (Fig. 3). The resistance of the inner pair of nails to twisting is naturally less than that of the outside pair.

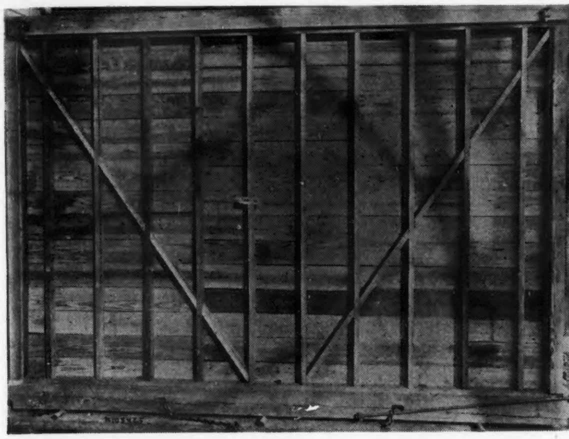
The effect of more nails on diagonal sheathing is much more important. Here the sheathing boards act with the framing as tension or compression members of a small truss, and each additional nail holding them in place adds considerably to the strength of the whole. Three nails instead of two increased the stiffness from 3.8 average to 5.2 and four nails brought it up to 7.5. Increases in strength were not measured, but were well beyond any strength likely to be required of frame construction.

Size of Nails. When a horizontally sheathed panel gives way, due to end thrust, it is usually the nails which give way first. They bend and twist before the wood splits. Heavier nails therefore might be expected to make a stiffer, stronger panel, and such in fact was the case. Two 10d nails instead of two 8ds increased stiffness of a horizontally sheathed panel 50 per cent and strength 40 per cent. When 12d nails were used strength and stiffness fell off again, perhaps because the large shanks split the boards more seriously.

Larger nails made little improvement in strength of diagonally sheathed panels, because the boards are not twisted about the studs when such panels resist pressure, and the greater strength of the nails was not brought into play.

Diagonal Sheathing. With two 8d nails per stud, a diagonally sheathed panel is about eight times as strong, and from four to seven times as stiff as a similar panel horizontally sheathed. When it is realized that this tremendous increase is secured in the average building with very little sacrifice of time and material, it is hard to believe that horizontal sheathing will continue to be used in any amount.

Types of Bracing. Several types of bracing are in common use to stiffen frame walls. Three of these methods were tested. Herringbone bracing (Fig. 4), or "fire-stopping" as it is sometimes wrongly called, increased the stiffness of a horizontally sheathed panel only 30 per cent and the strength only 10 per cent. Two-by-four



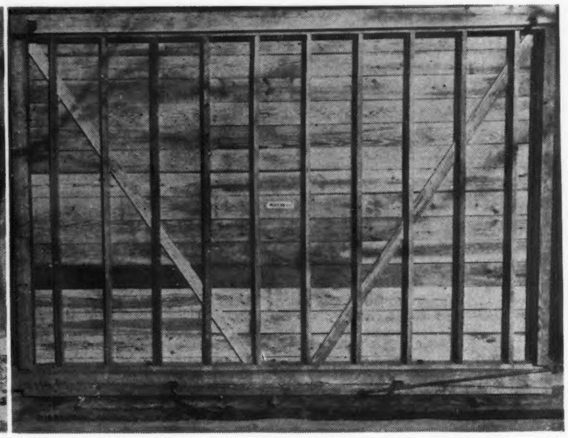


Fig. 5. (Left) Diagonal 2-by-4-inch cut-in braces improve stiffness 60 per cent and strength 40 per cent. Tightly fitted ends are essential if much benefit is to be had from them. Fig. 6. (Right) Braces of let-in strips are far the most effective, increasing stiffness 2½ to 4 times and strength about 3½ times

braces cut in between the studs (Fig. 5) brought improvements of 60 and 40 per cent.

The important discovery made in this field was that 1-by-4-inch strips, let into the faces of the studs beneath horizontal sheathing (Fig. 6), increase the stiffness from two and one-half to four times, and strength about three and one-half times. For situations such as in farm buildings, airplane hangars and small garages, where sheathing is omitted and siding applied horizontally, the let-in bracing strips offer far the best assurance of stiffness and strength.

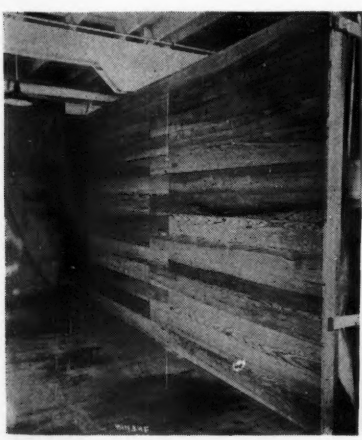
End-Matched Sheathing. Relatively few builders have had experience with the side and end-matched roofing and sheathing boards just becoming commercially available. Their advantage is that the ends do not have to be butted over the studs and no sawing is necessary except at openings or corners. Waste is almost eliminated.

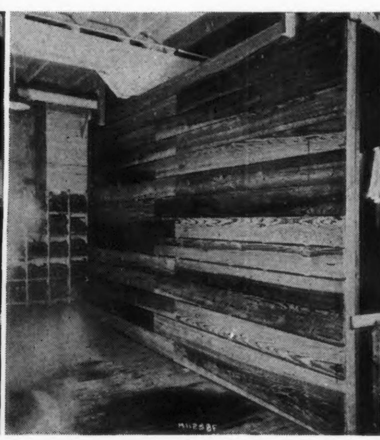
Tests were made to find out if walls thus sheathed are as strong and rigid as when the boards are butted over the studs. One-by-six-inch side and end-matched boards gave as good results as one-by-eight butt-edged boards.

Seasoning of Lumber. In some parts of the country, and particularly on farms or for low-grade building operations, buildings are often built of green or partly dried lumber. Results are seldom satisfactory. To discover what happens when such lumber dries out two panels were sheathed horizontally and two diagonally with green lumber. These were given a month under cover to dry out, and were then tested. The horizontally sheathed panels lost in drying about 40 per cent of the normal stiffness and 30 per cent of the strength of dry-sheathed panels. The diagonally sheathed panels decreased in relative stiffness from about 4.0 to 1.7. Strength tests were not made after seasoning.

The test described represents of course the most extreme conditions likely to occur as a result of using green lumber, and it would appear that several other factors may have as much or more influence on stiffness and strength than the use of green lumber. In this connection note the results of vibration tests described later.

Effect of Window and Door Openings. Openings reduce the resistance of a wall to longitudinal thrust (Table II). A double 28-inch window in a diagonally sheathed wall reduced its stiffness about 20 per cent and its strength about 40 per cent. Adding a 3-by-7 foot doorway decreased the stiffness 65 per cent and the strength 50 per cent. The wall was still twice as rigid and several times as strong as a horizontally sheathed wall with the same openings. Certain critical positions of openings may





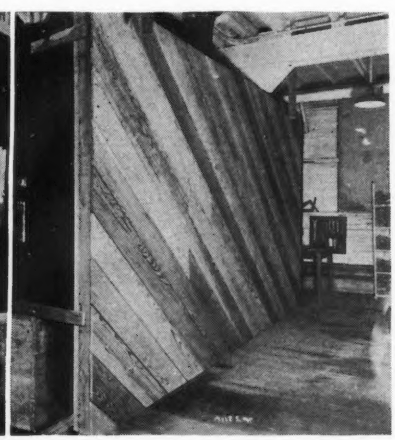


Fig. 7. (Left) Green horizontal sheathing when first nailed onto frame. Fig. 8 (Middle) Panel horizontally sheathed with green lumber, after seasoning for thirty days. Cracks represent 5⅛ inches shrinkage in 9-foot height. Moral: Use dry lumber. Fig. 9. (Right) View of panel diagonally sheathed with green lumber and allowed to season one month. Stiffness reduced 55 per cent

Fig. 10. (Left) A window opening framed in a diagonally sheathed panel reduced its stiffness 28 per cent and its strength about 40 per cent. Fig. 11. (Middle) A door and a window in a 9-by-14 foot diagonally sheathed panel reduce the stiffness 63 per cent and the strength 50 per cent. It is still much better than a horizontally sheathed panel without openings. Fig. 12. (Right) Diagonal let-in braces on a horizontally sheathed panel more than make up for the weakening effects of doors and windows Relative stiffness is 1.5; strength is 2.2

cause even greater reductions, but are not likely to occur under practical conditions.

Framing a door and window into a horizontally sheathed panel decreased strength and stiffness 20 and 30 per cent, respectively. Results of numerous other combinations may be seen in Table II.

Effect of Lath and Plaster. Wood lath and plaster, according to the tests, contributes surprisingly to strength and stiffness of a building. Installed on a panel without sheathing it afforded seven times the stiffness and four times the strength to be expected from horizontal sheathing. It increased the stiffness of a horizontally sheathed panel with window and door openings over 200 per cent Wood lath and plaster with horizontal sheathing and let-in braces around openings as in Fig. 12 made a panel slightly stiffer than diagonal sheathing with the same openings, and nearly as strong.

The influence of wall and partition openings in causing plaster cracks is thoroughly apparent from the results with plastered panels. The top plates of those without openings moved about ⅜ inch and a thrust of 8,000 to 12,000 pounds was necessary before plaster cracks developed; 800 to 1500 pounds thrust and only a few hundredths of an inch movement caused cracks in those with openings. The cracks in Figs. 13 and 14 show plainly the direction of stress and the tendency towards plaster cracks around openings. Cracks like those in Fig. 14 are often observable in wind-racked houses and like those in Fig. 13 in almost any poorly framed or braced structure.

Effects of Vibration. The question naturally occurs as to whether the extra stiffness and strength of walls, secured by bracing, diagonal sheathing or other expedients will survive the loosening effects of many storms, occurring throughout the life of a building. To discover what these effects might be, several panels were set in a vertical position on the table of a large box-testing machine. This machine is designed to jerk a box of merchandise, placed on its table, sharply back and forth, imitating the racking and swaying effect of railroad or truck transportation.

In this instance the "throw" of the machine table on which they were placed was such as to jerk the panel out of plumb at each vibration about two-thirds as far as it would go under the regular pressure test without sustaining permanent damage. Two horizontally sheathed panels and two diagonally sheathed panels were thus subjected to 50,000 cycles of vibration. One panel was horizontally sheathed with green lumber, allowed to dry out one month, and then given one million cycles of vibration.

Fifty thousand cycles, 100,000 severe endwise jerks, did not decrease the stiffness or strength of the dry-sheathed panels perceptibly. The losses in stiffness and strength of the green-sheathed panel after 2,000,000 jerks was only what might be expected of a green-sheathed panel subsequently dried out.

Significance of Tests. Over four-fifths of the houses in this country are of frame construction. When the number of garages, shops, barns and other farm buildings built of lumber are added to this total, the significance of the tests described above becomes apparent. Easily a billion dollars is expended on lumber for farm buildings annually. Perhaps another billion is spent on small garages, on airplane hangars and on other light-framed structures. Much more is expended on dwellings. A few simple precautions, such as the use of diagonal sheathing or effective let-in bracing, the use of heavier nails on horizontally sheathed structures or of more nails on those diagonally

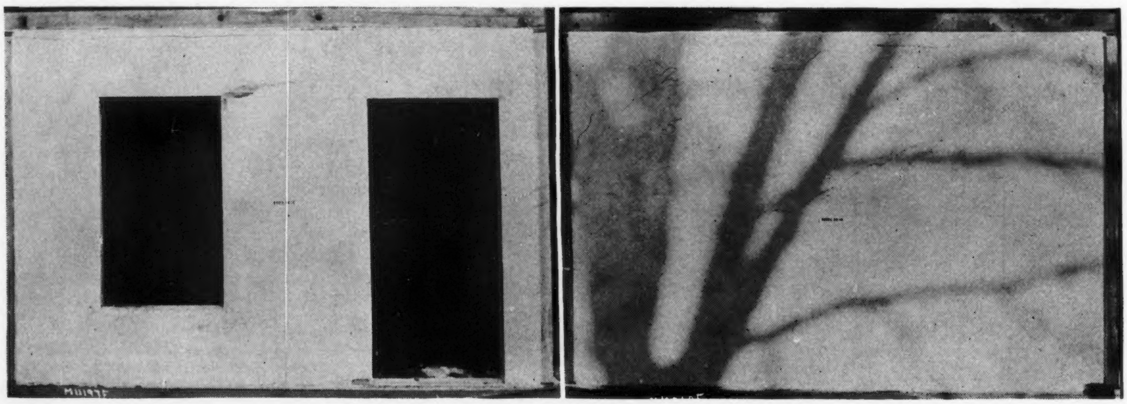


Fig. 13. (Left) Wood lath and plaster panel after test. The lath and plaster compensates for the weakening effect of openings. Fig. 14. (Right) The plaster cracks show plainly the direction of stress

sheathed; the employment of wood lath and plaster with its tremendous stiffening influence on the structure and of reasonably dry lumber, will increase the strength and stiffness of these buildings many times over that now generally realized, and will extend their consequent prospect of structural durability correspondingly.

In portions of the country threatened constantly with earthquakes or destructive winds, the further consideration of safety to life makes it almost imperative that the benefit of such precautions be widely advertised and certain features perhaps included in building codes.

Commenting on these tests, the Forest Products Laboratory's report states:

Plaster on wood lath may furnish all the rigidity necessary for most purposes under normal conditions. However, as the plaster begins to crack from shrinkage, settlement, or other causes, the rigidity of the sheathing comes more and more into play, thus in violent winds or earthquakes it is the sheathing that becomes all important in preventing complete destruction. It is logical too that slightly more resistance than is necessary to resist ordinary distorting influences will in the long run more than pay for itself through diminishing, if not entirely eliminating, needless annoyances and frequent maintenance costs that result from the structure getting out of alignment. Diagonal or well-braced horizontal sheathing affords far more rigidity than horizontal sheathing without bracing. Either diagonal or horizontal sheathing is important from the standpoint of insulation and also assists in distributing concentrated loads. The amount of stiffness essential to good construction is not yet known and must be determined by experience

The old braced-timber frame which originated in New England had far more rigidity than was needed perhaps, but the hundreds of old houses still standing bear witness to the fact that rigidity went hand in hand with permanence. Today we cannot afford to use in moderate-priced houses the heavy type of construction employed then. The modern adaptation of the braced frame with its small built-up corner posts and light corner bracing or the present-day balloon frame with the studs carrying through for two stories represent a great economy of material over the old style of braced frame.

Through a modern tendency to cut costs bracing is often omitted and horizontal sheathing is used because it is cheaper to put on. Although the inexpensive house is not necessarily an unsound house, nevertheless certain fundamental principles should be kept in mind so that, when construction methods are employed to reduce costs, the methods will be such that will result in no harm to the structure. Further, the added cost of adequate bracing is so small that it can hardly be felt in the total cost of the building.

(AUTHOR'S NOTE: The above-described experimental work was financed by the National Lumber Manufacturers Association, Washington, D. C., on a cooperative basis with the U.S.D.A. Forest Products Laboratory. A more detailed report of the test results may be secured from the Association upon request. Fully illustrated directions for house framing details may be secured from the Association at 25 cents a copy.)

A Machine for Distributing Sulphate of Ammonia in the Fertilization of Rice

By Roy Bainer[1]

THE use of sulphate of ammonia as a fertilizer for rice began in an experimental way at the U.S.D.A. Experiment Station at Biggs (Calif.) in 1914[2]. The results of the experiment indicated that over a period of six years an application of 100 pounds of sulphate of ammonia per acre gave an increase in yield of approximately 700 pounds per acre.

The results of the Cortena experiments on land cropped continuously with rice for eleven years showed that sulphate of ammonia applied at the rate of 150 pounds per acre in 1928 gave an average increase in yield of 1182 pounds per acre. In some plots the gain in yield was as much as 2087 pounds per acre.

The first commercial use of sulphate of ammonia on rice was at Richvale in 1925. In 1926 the growers increased the application from 100 to 125 and 150 pounds per acre. Yields again showed a substantial increase[3].

Growers who used sulphate of ammonia could not adapt it to large acreages due to difficulties of application. Various machines were tried. Those most commonly used were the drill, broadcaster and lime spreader. The lack of uniformity of the fertilizer as received from the various manufacturers presented a serious problem for the farmer. Some was hard and lumpy. In other cases extreme dampness would not permit the materials to flow through the machine. Many attempts were made to use existing types of machines but due to uneven spread and clogging the majority of rice farmers became discouraged. At the Biggs and Cortena experiment stations hand methods of application were resorted to in conducting the experiments.

MACHINE DEVELOPMENT

Many requests for a machine which would meet the practical requirements of the farmer were received by the California Agricultural Experiment Station and it was decided to attempt the development of a field spreader which would handle the commercial fertilizer as received from the manufacturer. The machine hereafter described was developed by E. J. Stirniman, associate agricultural engineer in the California Agricultural Experiment Station with the assistance of F. G. Hall, mechanician in the agricultural engineering division. This machine has been successfully used in spreading ammonium sulphate at the rate of 150 pounds per acre on more than 600 acres of rice land and it is now (1930) in use by a California rice grower.

The essential parts of the machine are a two-wheeled truck, upon which the mechanism is supported, a feed hopper, feed control, regrinding feed tube, fan and distributing system. The mechanism is driven by a power take-off. Fig. 1 shows a detail drawing of the machine. A description of its more important features follows.

Feed Hopper. A feed hopper 1 foot deep and 4 feet long is placed with the discharge end over the fan. It has flared sides spreading from 4 inches apart at the bottom to 16 inches apart at the top. An endless drag chain having drag lugs on every other link rides on the bottom of the hopper. The lugs are 3¾ inches wide and ¾ inch in height. An adjustable gate at the discharge end of the hopper acts as a crusher and regulates the size of lumps and amount of fertilizer fed into the fan.

Feed Control. Rate of feed in pounds per acre is controlled by the rate at which material is fed into the fan. The feed chain is driven through a 7.5-to-1 worm gear reduction from a countershaft, which in turn is driven by a belt from the power take-off shaft connected to the tractor. Eight-inch driving and driven pulleys carry the belt. A dog clutch is provided on the feeding mechanism so that it may be thrown out of gear while turning or crossing checks.

Regrinding and Feed Tube. A 4-inch diameter vertical tube 3½ inches long directs the fertilizer from the hopper to the fan. It enters just above the center of the fan. The fan shaft extends upward through the feed tube and carries three sets of 6 regrinding blades equally spaced. These blades are made up of 3/16-inch steel ½ inch wide and 1¼ inches long and are held to the fan shaft with

[1]Assistant agricultural engineer, Agricultural Experiment Station, University of California. Assoc. Mem. A.S.A.E.

[2]Jones, D. W. Rice Experiment at the Biggs Rice Field Station in California, U.S.D.A. Bulletin 1155, p. 20-29.

[3]Dunshee, C. F. Rice Experiments in the Sacramento Valley, California Experiment Station Bulletin 454, p. 7.

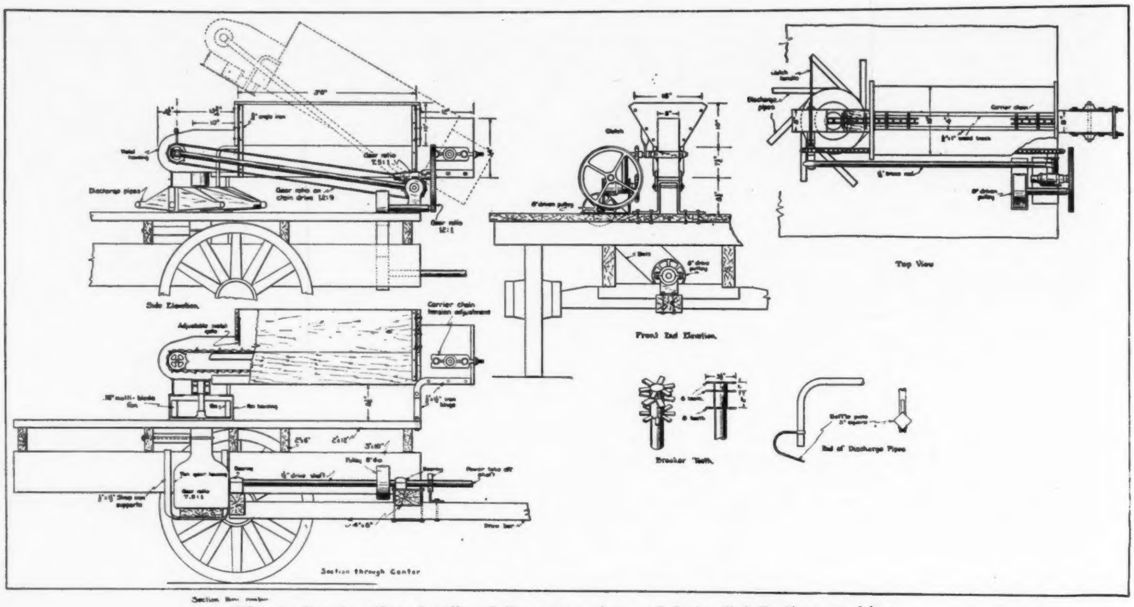


Fig. 1. Construction details of the ammonium sulphate distributing machine

set screws. Ends of the blades run sufficiently close to the feed tube to prevent clogging when operating under damp conditions. It is necessary, to insure a uniform rate of feed, to break large lumps into pieces two to three inches in diameter before placing the sulphate in the hopper.

Fan. A Sirocco, multi-blade type fan, 15 inches in diameter, having twenty-eight blades 1¾ inches wide and 4½ inches long is horizontally mounted and operated at 2700 r.p.m. Fertilizer passes directly from the regrinding and feed tube into the center of the fan. From here it is carried in the air blast, through the blades and out through the distributing system.

Distributing System. Eight 2-inch pipes are attached tangentially to the fan housing and spaced equal distances apart. The discharge ends are carried to within 1½ to 2 feet of the ground. Each pipe is arranged to cover a 2-foot strip. A 3-inch square spreader plate is placed at an angle with the horizontal of 30 degrees, 2 inches below the discharge to facilitate uniform spreading of the fertilizer, (Fig. 2). The arrangement of pipes is shown in Fig. 3.

Power. Mounted on a two-wheeled cart, the machine is pulled by a light-weight tractor and operated by a power take-off. With this type of power unit sufficient commercial fertilizer may be carried on the cart to supply the machine for a half-day period.

Accessibility. For accessibility the forward end of the hopper is hinged so the hopper can be lifted free from the distributing mechanism as shown in Fig. 4 without interfering with the drives. When the feed unit is lifted from the top of the fan case the regrinder and fan are exposed. These may be removed readily by loosening the set screws and lifting the unit out through the top of the fan case. In case a distributing tube should become clogged it may be cleaned by removing the fan unit and pushing the material through, or by unscrewing the pipe at the fan case and allowing the fan to clean the opening under operation. The power take-off from the tractor is placed under the deck of the cart. This provides ample space on the deck for carrying the sacked fertilizer.

Operation. It is desirable to have an operator other than the tractor driver when fertilizing irregular fields. The acreage covered per hour will depend on the speed of travel and the size and shape of the field. When traveling at a rate of 2¼ to 2½ miles per hour from 25 to 40 acres per day can be covered. When fertilizing rice land having small irregular checks the ends of the distributing pipes may be set high enough to clear the levees when operating the machine across the levees.

If the distribution unit is mounted on a wagon and a separate power unit employed, it is recommended that no less than a 5-horsepower engine be used. It is quite desirable to keep a constant fan speed and rate of travel to secure uniform distribution and prevent clogging. The machine should not be operated at full speed when empty.

Fig. 2. (Left) View showing spreader plates below the discharge openings showing the spider-like arrangement of the distributing pipes. Fig. 3. (Middle) Bird's-eye view of the machine Fig. 4. (Right) The hopper in the raised position giving access to the fan and regrinding blades

Lubricants and Fuels for Tractor and Motor Vehicle Engines[1]

By Harvey T. Kennedy[2]

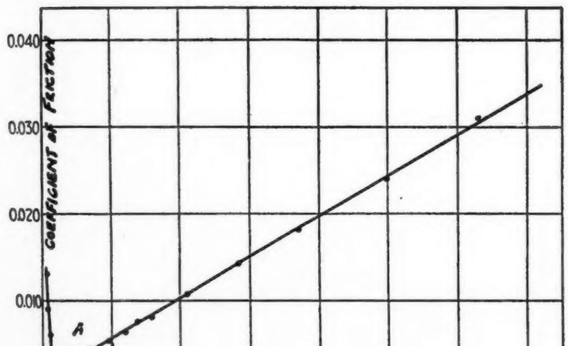
DURING the past ten years there has been a rapid increase in the use of the internal-combustion engine as a source of farm power. Thus in 1920 there were, according to the U. S. Census Bureau, 246,000 tractors on farms in the United States, while in the spring of 1929 the most reliable estimates place the number at 853,000, with indications that by 1930 there will be over one million tractors in use, or more than four times the number for 1920.

This phenomenal increase in the use of automotive equipment, which includes motor trucks and passenger cars, as well as tractors, renders the procurement of suitable fuels and lubricants for them at once of serious economic concern for the farmer and a matter to consider in connection with the conservation of natural resources. While a thorough discussion of all the phases of this subject is, of course, impossible in a short paper, an attempt will be made to summarize those points of greatest interest in connection with the choice of suitable lubricants and fuels, and economical purchase of them.

Lubricant Requirements. Let us first consider what is required of an automotive lubricant for optimum performance. Since the value of the equipment lubricated is in general very large compared to the cost of fuel or oil, perhaps the most important service of the lubricant is to reduce wear on rubbing surfaces to the minimum, and to prevent seizure or breakage. It should reduce friction to the minimum consisten with safety, to avoid waste of power. It should allow the motor to be turned over at fair speeds with the starting torque available, even in the coldest weather, and its consumption in the engine should not be excessive. That portion of the oil which finds its way into the combustion chamber should burn with the minimum deposit of "carbon." Further, the oil should as far as possible continue to meet the requirements enumerated, notwithstanding the action of high temperatures and the diluting action of gasoline. It is also desirable that noise be reduced to the minimum.

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, Amherst, Mass., October, 1929.

[2]Associate scientist, Bureau of Standards, U. S. Department of Commerce.



TYPICAL PLOT OF JOURNAL-FRICTION OBSERVATIONS; $L/D = 1.00$, $C/D = 0.00100$

Fig. 1. Typical plot of journal-friction observations (L/D=1 00; C/D=0.00100). This curve is reproduced by courtesy of S. A. McKee and T. R. McKee from the Transactions of the American Society of Mechanical Engineers (Applied Mechanics), Vol. 51, p. 161-171. Viscosity is expressed is absolute units, not Saybolt seconds.

While it is comparatively easy to write down the requirements for an ideal lubricant, it is more difficult to choose from those commercially available the most satisfactory and economical lubricant for a given purpose. In the first place, no commercial lubricant excels or even equals all other lubricants in every respect, and it is necessary to decide which characteristic is of greatest importance for the purpose at hand. For example, oils that are best from the standpoint of starting commonly have a tendency to form more combustion chamber deposits. Second, the performance of a lubricant depends to a large extent on the mechanical condition of the engine, and the selection of oils on the basis of performance tests alone, even where these tests are carefully controlled, is exceedingly difficult. Thus while valuable statistical information might be obtained from data on a fleet of trucks or taxicabs, it is quite certain that very little can be learned from the ordinary operation of a few vehicles.

To provide a basis of selection of lubricants, a great amount of effort has been expended at the Bureau of Standards and elsewhere in devising laboratory tests which are reproducible and which bear a relation to the service that may be obtained from the oil. Although much has been accomplished, correlation of laboratory tests with service tests is still incomplete in many cases, and present laboratory tests in some instances require improvement or replacement. But even in their present condition, it is believed that these laboratory tests provide by far the best means of selecting oils.

Inventory of Tests. It will be interesting to take an inventory of the tests ordinarily made on lubricants in the laboratory, and to discuss how each test is related to the desirable qualities already mentioned. First, and unquestionably the most important, is the viscosity or body, at or near the operating temperature. Viscosity is a measure of the resistance to flow, and thus is intimately connected with the power losses in the engine. It is also a measure of the thickness of the oil film that separates the rubbing surfaces, and thus important from the standpoint of wear and noise. Fig. 1 shows the general relation between coefficient of friction (f) and speed (N), load (P) and the viscosity (Z) of the lubricant, each point being taken under steady running conditions. Internal-combustion-engine bearings do not run under these conditions, the magnitude and direction of the forces changing throughout the cycle, but we may use the chart as a rough indication of the effect of viscosity, assuming speed and bearing pressures constant.

It will be seen that the lowest coefficient of friction is represented by the point A, and for a steady-running bearing the least power loss would result if the lubricant were chosen to give this minimum. However, since the point of minimum friction is not the point of minimum wear, especially when there is finely divided abrasive material present in the oil, and since a reasonable factor of safety to cover unusual conditions is necessary, a point to the right of A is ordinarily chosen. For automotive bearings it is necessary to provide a very large factor of safety because temperature, and therefore viscosity, varies over a wide range, and speed and load are highly

variable. Also. dilution by fuel occurs to some extent in practically all engines, and the viscosity of the new oil must be high enough to take care of this variable. Notwithstanding these uncertainties, it is as true for a motor bearing as for one that runs under carefully controled conditions, that, if the viscosity of the lubricant is too low, increased wear and perhaps increased friction will result, while, if too high, a needless loss of power results, and between these limits a "happy medium" can be selected.

The plot shown in Fig. 1 cannot be used in the practical selection of automotive lubricants, due to the large number of variables difficult to measure. Thus, the viscosity is greatly affected by changes in temperature, and by dilution of the oil by fuel, and the coefficient of friction for a given value of ZN/P depends on the material and smoothness of the rubbing surfaces. For this purpose, however, there are the recommendations of the manufacturers of the equipment, as well as those prepared by oil refiners. The following facts should be kept in mind when using these recommendations:

1. Knowledge concerning the factors involved in automotive lubrication is not sufficiently exact to warrant a precise choice of viscosity. Recommendations by various oil refiners for the same equipment vary between wide limits.

2. New engines and those tightly fitted on repair have smaller clearances, and a lighter (i.e. lower in viscosity) grade of oil should be chosen for the first few thousand miles of operation.

3. Engines require heavier oil as wear progresses, since clearances are larger and impact stresses greater; also because oil consumption and noise become more important items.

4. When operating conditions are such that dilution by fuel is abnormally high, a correspondingly heavier oil should be employed. Dilutions up to 15 or 20 per cent are usually assumed in the recommendations.

5. Colder temperatures in winter tend to increase the percentage dilution, and this would make necessary a heavier oil. On the other hand, this is to some extent compensated for by the fact that oils have higher viscosities at the lower temperatures.

To summarize the importance of viscosity at the operating temperature, it may be said that it is the most important, if not the only characteristic of the oil that affects wear, power losses due to friction, and noise.

While operating temperatures depend on the temperature of the surroundings, speed, load, and equipment design, it would be desirable, in choosing oils, to make this selection on the basis of some average operating temperatures.

The fact that oils having the same viscosity at one temperature may have widely different viscosities at other temperatures, makes it desirable in some cases, to investigate the effect of temperature on viscosity. Fig. 2 shows a chart prepared by MacCoull, which is so constructed that the relation between temperature and viscosity for any oil is a straight line. Oils from the same source may be represented by essentially parallel lines. We have drawn lines characteristic of naphthene, paraffin and mixed base oils. One service available from this chart is that the effective viscosity, as regards the difficulty in starting an engine at low temperatures may be estimated, even at temperatures below the "pour point," or the point below which the oil apparently solidifies. Secondly, it may be used to predict viscosity at higher temperatures, such as obtain on the cylinder walls, and thus estimate relative oil consumption. Curiously, it also serves to estimate the effect of dilution, when the temperature scale is regraduated in percentage dilution as shown in Fig. 2. The viscosity-temperature line then becomes a viscosity-dilution line. Thus, the chart shows that in regard to viscosity at 100 degrees Fahrenheit, 10 per cent dilution has the same effect as raising the temperature of any oil 27 degrees (15 degrees centigrade); 20 per cent dilution, 57 degrees (32 degrees Centrigrade),etc. The small circles represent the viscosities of the same oils diluted with solvent naphtha, a material similar to the less volatile portions of gasoline. Flat viscosity-temperature lines are therefore important where temperatures far removed from normal are encountered, where oil consumption is a serious factor, or in equipment where high dilution is unavoidable. For all ordinary conditions, engines are built to take care of oils with the steepest slope shown.

Another test which is generally included in complete lubricating oil specifications is Conradson carbon residue. It consists in volatilizing the oil at high temperatures under controlled conditions and measuring the residual "carbon." When applied to oils of the same type, at least, this test appears to measure the tendency of the oil to build up combustion chamber deposits, and thus to serve as an index to trouble from this source.

In this connection, however, it should be noted that the carbon deposit which will form in any engine generally reaches an equilibrium value. Some engines operate at temperatures sufficiently high that the equilibrium value of carbon deposit is not enough to cause trouble, and under these conditions the carbon residue test is not an important item. It is possible that a vacuum distillation test would serve as a better index to engine carbon formation than the Conradson test, and evidence for this belief has recently been presented[3].

Oxidation Tests. Various forms of oxidation tests have been developed or suggested. The most reproducible and widely used is that developed by T. S. Sligh at the Bureau of Standards[4].

It consists in holding a 10 gram sample of the oil under test at 200°C (392°F) for 2-½ hours in an atmosphere of oxygen, diluting the oxidized oil thus obtained with petroleum ether, and weighing the precipitate formed. The mass of the precipitate, in milligrams, is called the oxidation number. The test was designed to measure the tendency of oils to deteriorate at high temperatures, which deterioration in some cases causes troublesome sludges, abnormal increases in viscosity, and probably an increase in engine carbon. The importance of this test will probably increase as the use of oil filters becomes more general, and oils are used for longer periods of time before changing.

The copper-strip corrosion test is frequently specified in lubricating oil specifications. It is obvious that oils must not corrode the machinery which they lubricate. As a matter of fact, very few oils fail to pass the corrosion test, and corrosion due to commercial lubricants is a rare occurrence.

Tests for Identification. Among the tests which may be of service from the standpoint of identification, but which are of little or no importance as specification items are flash and fire points, color and specific gravity. Flash and fire points, for new oils, are closely related, and while it has been claimed that they are a measure of oil consumption under very high speed and high temperature conditions, the evidence for this belief is far from conclusive. For ordinary operation, it is quite certain that they have no significance. Some limit on color might be desirable, since light-colored oils permit foreign matter to be observed more easily than dark ones. Also color may be an indication to a refiner of the completeness of some treatment during refining. But otherwise, we know of no relation between the color of a lubricant and any desirable characteristic that cannot be more satisfactorily measured by other tests. If flash and fire points and color enter into lubricating oil specifications, therefore, limits should be set so that any reasonably well-refined oil can meet them. Limits on specific gravity, or

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[3]Livingston and Gruse, Journal of Industrial and Engineering Chemistry, Vol. 21, page 904, (October, 1929).

[4]Proceedings, American Society for Testing Materials. Vol. 24, Part II, p. 962 (1924).

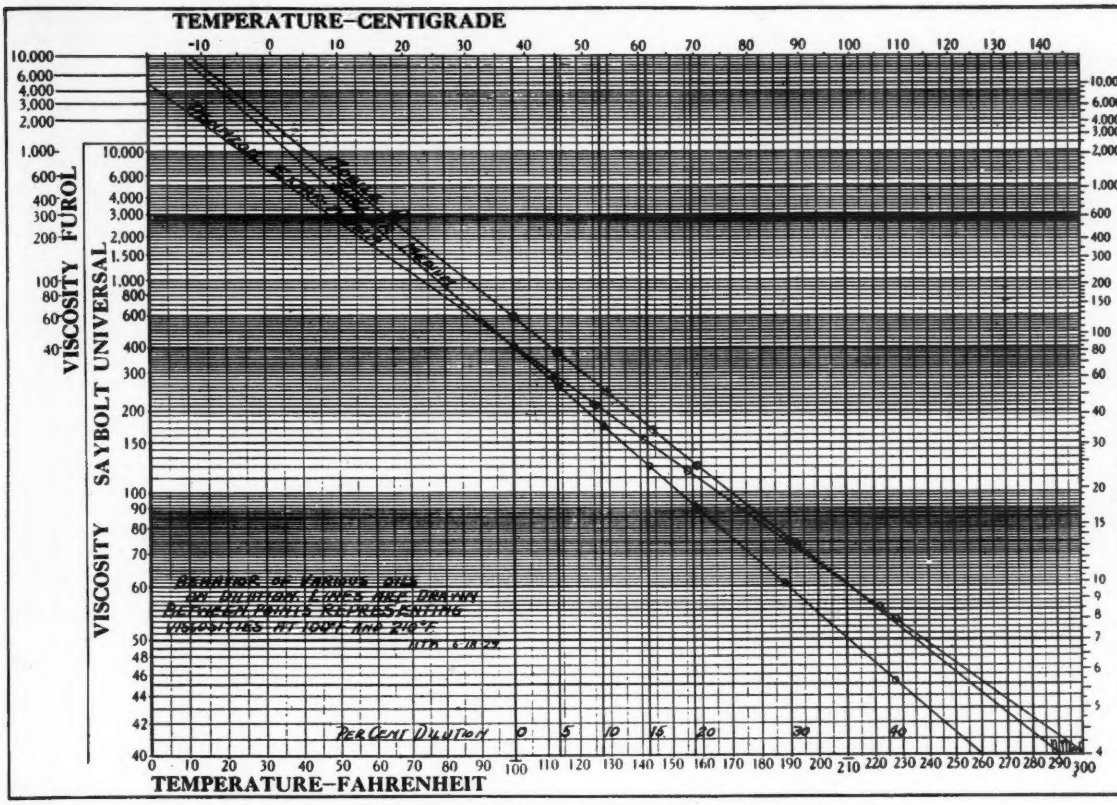


Fig. 2. The MacCoull viscosity-temperature chart for lubricating oils

degrees A.P.I. if made a part of specifications, serve only to decrease the source of supply and therefore probably increase the cost, without guaranteeing any desirable quality whatever.

Last we may mention neutralization number, which is a measure of organic acids present. While these acids are in general so inactive that they have no harmful action on the engine, this test may have some relation to emulsions and sludge-formation in the crankcase. While a large amount of work has been done to show the importance of this test in other fields of lubrication, it cannot be said to be of proven value when applied to the internal-combustion engine.

We have dwelt at some length on the various tests frequently made and specified on lubricants, and the probable value of these tests in securing suitable oils, with little reference to the particular type of engine in which used. It will be of interest now to consider the special requirements for lubricants for tractors, trucks and passenger cars. In general it may be said that tractor and truck engines normally operate at a higher fraction of their possible power than pleasure cars, since reserve power and acceleration are less important, and economy more carefully considered. Average bearing pressures are likely to be higher, as are operating temperatures. It is therefore necessary to choose heavier oils for trucks and tractors, especially the latter, because tractor oils are more liable to become contaminated with sand, dust, etc., and a heavier grade of oil tends to protect the rubbing surfaces from the abrasive action of these materials. Heavy oils are especially necessary for tractors if kerosene or other relatively non-volatile distillate is used as a fuel. The carbon residue test is probably less important for tractors and trucks than for passengers cars, because the former operate at higher temperatures.

Various systems of classifying oils are in use. There is that of the Federal Specifications Board, which specifies the viscosities of the lighter grades at 100 degrees Fahrenheit, and the heavier grades at 210 degrees. The system adopted by the Society of Automotive Engineers, commonly called the S.A.E. System classifies the lighter grades at 130 degrees and the heavier grades at 210 degrees. Average operating temperatures are nearer to 70 degrees Centigrade (158 degrees Fahrenheit), and this temperature is convenient for the measurement of viscosities of all grades. A system of grading using 70 degrees Centigrade as a basis is in use by one large distributor of lubricating oils, the complete specifications for which follow:

Grade	Viscosity, Saybolt sec. at 70° C (158° F), Method*		Flash Point, min. degrees F., Method 110.32*	Union Color Max., Method 102**	Pour Point degrees F. Max., Method 20.12**	Carbon residue Max., Method 500.12**
	Minimum	Maximum				
Light	65	75	335	7	40	0.20
Medium	80	90	345	8	45	0.45
Heavy	100	120	360	8	50	0.60
Tractor	180	220	380	6 (diluted)	50	1.60
Motorcycle	300	340	400	8 (diluted)	50	2.00

NOTE 1: The neutralization number shall not exceed 0.30 (Method 510.31).**

NOTE 2: A clean copper strip shall not be discolored when submerged in the oil (Method 530.31).

*The method used is the same as Method 30.41 of the Federal Specifications Board, or A.S.T.M., Method D88-26, except that the temperature of the test is 70 degrees (Centigrade) instead of the temperature required in the above references.

**Method numbers refer to Bureau of Mines Technical Paper 323-B, obtainable from the Supt. of Documents, Government Printing Office, Washington, D. C., at a cost of 15 cents (stamps not accepted).

It will be noted that limits on characteristics which are relatively unimportant are made sufficiently lenient to allow any oil, reasonably well refined and not contaminated, to comply.

Choosing Fuels. The problem of choosing fuels is much easier than that of choosing lubricants, largely because our knowledge in this field is more exact, and failures of the fuel to perform satisfactorily are more easily observed. Let us state the qualities desired: The fuel must allow the motor to be started in a reasonable number of revolutions at the lowest starting temperatures. It must not dilute the lubricating oil excessively. It should provide full power and quick acceleration without "knocking." It should give maximum economy in miles per gallon. No "gum" should be deposited in the inlet passages, such as the carburetor, manifold, or on the intake valves. Finally, no corrosion should be caused by the fuel or the products of combustion which find their way into the crankcase.

As a result of extensive published researches carried on at the Bureau of Standards, it has been found that the only characteristic of the fuel having any connection with the ease of starting is the lower portion of the distillation curve, and that for practical purposes the temperature at which 10 per cent of the fuel has been distilled off by the standard A.S.T.M. distillation test measures this characteristic. Similarly the tendency of the fuel to dilute the lubricant may be measured by the ninety per cent distillation temperature, and if operating conditions are such that high dilutions occur, trouble from this source may be reduced or eliminated by the choice of a lower ninety per cent point, in addition to choosing a heavier oil.

The power and economy obtainable from an engine depends to a much greater extent on its design and adjustment than on the fuel used. If a fuel has a suitable distillation range from the standpoint of starting and dilution, practically the only characteristic affecting the power and economy obtainable is the "anti-knock" value. The anti-knock value, while of considerable importance, has not found its way into most specifications, because of the difficulties in developing a standard test for it. Fortunately, however, in most automotive equipment it is easy to tell when detonation occurs, and for most types of engines fuels at ordinary prices may be chosen which do not knock seriously.

Economy is particularly affected by carburetor adjustment and design. Increases in miles per gallon of fifty per cent due to leaner carburetor setting are not uncommon.

The tendency of fuels to form gum has been the subject of much research in recent years, largely because many of the best modern fuels, if not properly refined, are liable to cause troublesome gum deposits. This is mainly a refiner's problem, however, and fortunately very few fuels reach the consumer which are not satisfactory in this respect.

The problem of corrosion in the crankcase has been shown to be largely a matter of sulfur content of the fuel, due to the formation of acids during the process of combustion. For this reason, carefully drawn specifications include an upper limit, such as 0.10 per cent, on the sulfur content. This limit is frequently exceeded in the case of blends made up from poorly refined benzol and gasoline. High-sulfur fuels are particularly to be avoided in winter and in cold climates, since under these conditions water is most likely to be present in the crankcase, which accelerates the corrosive action of acids formed by the combustion of sulfur. Gasoline should not be sufficiently volatile to boil in the fuel lines or carburetor, as vapor lock may result. When this happens, it may be necessary for one to wait for the fuel to cool down before the engine can be started again. This trouble has been found to be eliminated if the ten per cent distillation point is not too low. For this reason a minimum ten per cent point, corrected for distillation loss, is included in the new government specifications for motor fuel, which cover two grades and are as follows:

U. S. Motor Gasoline

1. Copper strip corrosion test, only slight discoloration permitted.
2. Ten per cent distillation not over 176 degrees (Fahrenheit) and not less than 122 degrees. With a provision that purchasing officers may reduce the maximum to 167 to 158 degrees when cold starting is required. The limit will be 158 degrees in general when freezing temperatures are expected. For tropical storage, etc., the lower limit may be raised to 140 degrees. A correction to the 122-degree limit is also provided to encourage stabilized gasolines.
3. The 50 per cent point not over 284 degrees.
4. The 90 per cent point not over 392 degrees.
5. The end point not over 437 degrees.
6. At least 95 per cent recovery in the distillation.
7. Sulfur not exceeding 0.10 per cent.

Motor Fuel V. Motor Fuel V is intended as a special high volatility gasoline for use in fire apparatus, ambulances, and other emergency vehicles requiring ease of starting and freedom from crankcase dilution, particularly in cold climates or seasons of the year. The requirements for this fuel are the same as for "U. S. Motor" with the following exceptions:

1. The 10 per cent point not over 149 degrees (Fahrenheit) in place of 176 degrees.
2. The 50 per cent point not over 257 degrees in place of 284 degrees.
3. The 90 per cent point not over 356 degrees in place of 392 degrees.
4. The end point not over 401 degrees in place of 437 degrees.

The steady operating conditions and relatively high temperatures of tractors make it possible to use in them fuels of relatively low volatility. Thus, kerosene has been widely used, and, provided the lubricating oil is not diluted excessively, considerable economies result, because of the lower cost of kerosene and because of a slightly higher heating value per gallon. It is obviously unnecessary in this case to insist on a material that would be satisfactory as an illuminating oil, since the requirements for the two services are essentially different. There follows a specification for such a fuel which, to avoid confusion, is called "engine distillate."

Engine Distillate. This specification covers the grade of motor fuel used for tractor engines and other internal-combustion engines which are designed to use kerosene and similar fuels of low volatility. It shall conform to the following requirements:

1. The oil shall contain no water or other foreign matter.
2. It shall not show either an acid or alkaline reaction (Method 510.1).
3. Distillation Range: The 20 per cent point shall not exceed 220 degrees Centigrade (428 degrees Fahrenheit). The 90 per cent point shall not exceed 315 degrees Centigrade (599 degrees Fahrenheit) (Method 100.23).
4. The sulfur content shall not exceed 0.15 per cent (Method 520.11).
5. All tests shall be made according to Bureau of Mines Technical Paper 323B, to which the above method numbers refer.

* * * *

The advantages of purchasing lubricants and fuels for tractors, trucks and motor cars on specifications are two-fold: First, assuming properly drawn specifications, a product is obtained that is satisfactory for the purpose intended; and, second, a very considerable saving may be realized, since quality is described and competitive bidding made possible.

Electric Refrigeration on the Farm[1]

By W. L. Cummings[2]

ALMOST overnight thousands of farms have rebuilt their milk cooling rooms and remodelled their kitchens to accommodate electric refrigeration. For five years men from college agricultural extension departments, representatives from electric refrigerator manufacturers, and many others have been watching wattmeters, recording thermometers and other instruments that have universally told the tale of successful experience with electric refrigeration on actual farm installations.

First in importance is the household refrigerator. All the desirable features of these cabinets in city homes apply to rural conditions. I refer to the necessity, economy and luxury of electric refrigeration: the low, evenly regulated temperatures; the dry refrigeration atmosphere which makes for great food-preserving power; the independence from failure of the ice supply; elimination of the unclean drain from melting ice; the new sanitary conditions of the modern electric refrigerator; the low operating cost; elimination of quick food spoilage, disease-causing food decay, and money-wasting food losses; convenience; frozen desserts and ice cubes; aristocratic appearance; and all the other features.

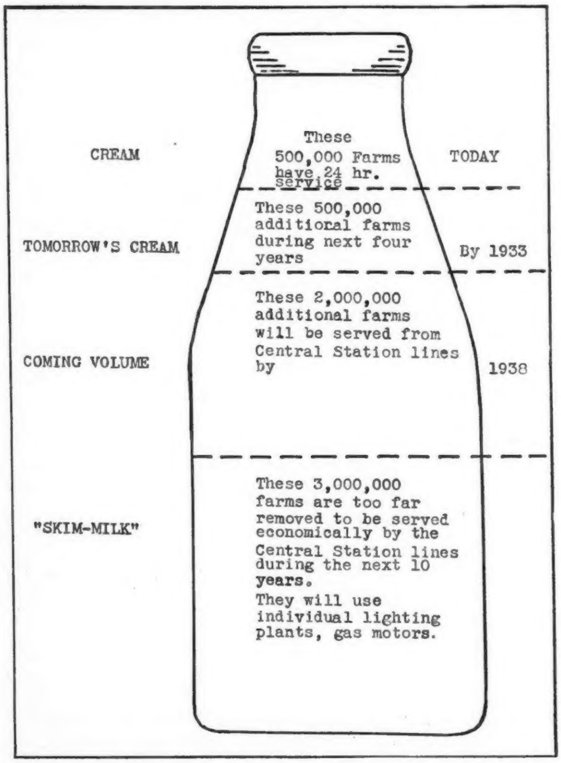
As time passes we find farmers specializing in their work: One farmer grows potatoes; another, fruit; a third, milk. The modern farmer is dependent on outside sources for his complete list of food supplies. This dependence means that he is looking to some means of food preservation to make better his conditions rather than spoiled by this new "specialization". With electric refrigeration he not only finds a solution to this problem, but a means of greater enjoyment of chilled foods, frozen desserts, refreshing drinks and a greater assortment of table foods.

A number of farms will be interested in electric refrigeration for the storage and conditioning of poultry, eggs, butter, fruits, vegetables, fresh killed beef, and many other food products. There will be special refrigeration supplied to incubators that are too warm. Then there is ice making by electric refrigeration, room cooling, and water cooling.

More important probably will be the results of the new "frozen food" busisness It is not beyond belief that the time will come when certain foods will be properly grown and prepared, frozen on the farm and held frozen throughout the entire period of transportation to jobbers, dealers, retailers—right to the point of final consumption. A good example of the possibilities of this industry is shown to us today in the handling of frozen strawberries. Important developments are certain to come in this field when one considers the technical resources and financial power of the strong corporations that are now developing this method of handling foods.

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Amherst, Mass., October, 1929.

[2]Promotion manager, refrigeration equipment, Home Electric Light and Power Equipment Company.



Graphic representation of the farm market for electric refrigerators

DAIRY REFRIGERATION

After milk leaves the cow minute dust particles settle rapidly into it. The surface of milk pails, strainers and all containers add more foreign particles. Almost immediately colonies of bacteria start to grow around the nuclei of "microscopic dirt" in the fresh-drawn milk. At temperatures between 60 and 90 degrees (Fahrenheit) this growth is rapid. From temperatures of 50 degrees to 33 degrees this growth is held for a period of days within safe limits.

All equipment designed for the handling of milk must therefore incorporate not only features of cooling power, but also real features of cleanliness, ease of draining, and smooth accessible inside lining, of material which can be scrubbed and readily kept clean.

The electric milk cooling apparatus which has been adopted as standard by a large percentage of the authorities consists of an insulated tank with a 22-inch water level (maintained by a stand-pipe) and containing a volume of water equal to five times the volume of milk to be cooled at each of two milkings. This water bath is cooled to temperatures near 34 degrees by immersing a cooling coil in the water bath. In recent years this cooling coil has been placed inside of a small brine tank, and the brine tank is immersed in the water bath. The purpose of the brine tank is two-fold: First, to increase the surface area in contact with the water, thereby reducing the collection of ice and increasing the efficiency of heat transfer; second, for greater ease of cleaning the tank. The brine tank (made of galvanized iron) is easy to clean and accessible. To the cooling coil in this brine tank, is connected a standard electric refrigeration compressor unit of proper size.

Determining the capacity of refrigeration unit required is too simple a matter of physics to go into in detail. The number of pounds of milk to be cooled per day multiplied by the specific heat of milk (0.9) and by the heat drop desired, in degrees Fahrenheit, will give the number of B.t.u.'s to be removed from the milk. The amount of heat leak will depend on how well the tank is insulated and how often and how long the cover is raised. It may ordinarily be expected to run between 5 and 10 per cent.

The refrigeration unit should be large enough to remove all the heat required under full load by operating 10 to 12 hours per day.

The next point to examine in an electric milk cooling tank, after considering overall capacity and ease of cleaning, will be the speed of cooling, or the "sharp cooling" load. It is vital that warm milk be cooled quickly from 90 to 50 degrees in order to check the growth of bacteria.

Let us analyze a four-can tank in regard to speed of cooling.

Total milk per day—4x80=320 pounds
Pounds milk per milking—320÷2=160 pounds
Pounds water and brine in four-can tank—160x5=800 pounds

Now, if

A=pounds of water and brine
B=temperature rise necessary in water to cool milk 45 degrees in one hour
C=pounds of milk, and
D=specific heat of milk,

we can say, for cooling milk from 95 to 50 degrees,

$$A \times B = C \times 45 \times D$$

Solving for B, we find

$$B = \frac{C \times 45 \times D}{A}$$

Substituting figures above we find

$$B = \frac{160 \times 45 \times .9}{800} = 8.1 \text{ degrees rise in water temperature}$$

Since it is quite feasible and common to lower water to temperatures around 35 degrees before immersing the 40-quart cans, we can arrive at a maximum water temperature as follows:

$35+8.1=43.1$ degrees as a maximum water temperature on a speed of cooling schedule of one hour.

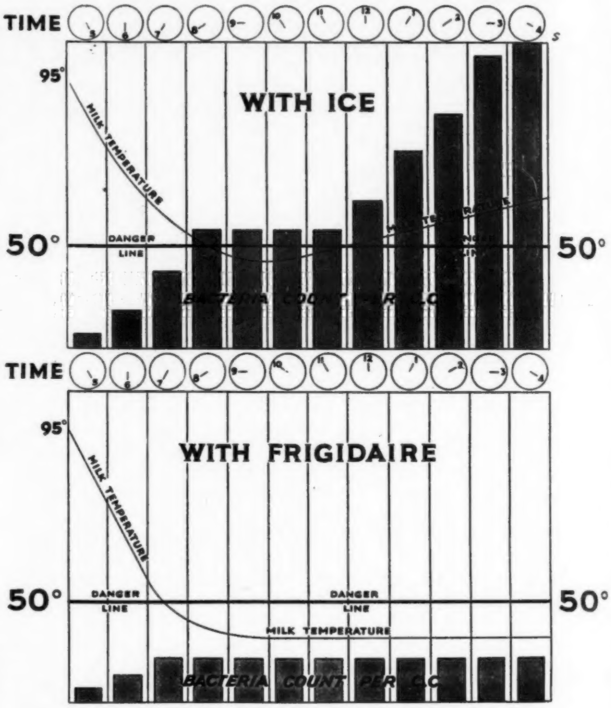
There is adequate power in the above hook-up to handle the "sharp-cooling" load, especially when one considers that the compressor will run during the hour of cooling. During this hour, the compressor has a capacity of 1440 B.t.u.'s which can materially increase the speed of cooling, or the refrigeration capacity available. This compressor capacity, as well as the factors of service and heat leak have been omitted from the above analysis for the sake of simplicity.

Several experiments have been made with tank-type coolers. One is stirring the milk with a stirring rod during the period of "sharp cooling." Recording thermometers show that this stirring accelerates the speed of cooling greatly. It is possible by this method to cool milk from 95 to 50 degrees in 45 to 55 minutes. However, stirring rods do not carry the sanction of authorities despite their usefulness in speeding the rate of heat transfer. The reason for this is that contamination gets into the milk from the stirring rods when they are not carefully prepared before each stirring.

Another experiment is agitation of the water in the tank. Speed of cooling is materially increased by this method. Cleanliness is still retained.

We have checked the bacteria count of the product that is finally dumped at the creamery. We find that the producer who dumped milk of the lowest bacteria count at an Addison County (Vt.) creamery last August handled his milk as follows: He took clean milk, strained it into sterile 40-quart cans, capped up these cans immediately, and immersed them in a tank-type milk cooler of the 5-to-1 design ratio. Similar reports come to us from a creamery in central New Hampshire, and from many other sources. Simplicity of handling, trouble-proof procedure and elimination of the human element, all are desirable features in any machinery that is put at the disposal of the farmer.

Aerators, either tubular, conical or corrugated are the fastest means of cooling milk in a practical manner. Many of these specialties will be used in the handling of the



A comparison of the effectiveness of cooling milk with ice and electric refrigeration

milk dealers' refrigeration problems. Brine at 24 degrees will be circulated through the aerators, and dry storage rooms will be refrigerated. The use of the aerator will be of limited value on the farm of the small producer, because of the difficulty of cleaning, protecting from dust and flies, and because of the lack of time and labor to properly operate an aerator.

Several creameries have already reported noticeable improvement in the quality of milk received, even when only a limited number of their producers have installed electric refrigeration. It is expected that creamery operation improvement will be one of the most important results brought about by the advent of electric milk cooling equipment.

A score card to use in judging an electric milk cooling machine might contain the following points to check:

1. Price
2. Capacity (B.t.u. ratings under peak-load conditions)
3. Ease of cleaning
4. Insulation
5. Structural strength
6. Protection from corrosion and rust (Cork sealed in Hydrolene? Galvanized iron throughout? "Water pockets?")
7. Convenience (Lids easy to lift, drop-front sills, etc.)
8. Is there a strong local organization set up and able to handle the problem of skillful installation and quick, inexpensive, effective service?
9. Operating expense for electricity
10. Does it meet the approval of the producer, creamery, inspector and all the others who will be passing approval on it?
11. Is it simple, trouble-proof and easy to operate?

The above outline is a guide by which to judge the value of any new milk-cooling equipment that may be developed from time to time for the milk producer.

Effect of Types of Storage Bins Upon Quality of Wheat[1]

By F. C. Fenton[2]

THE farm storage of wheat presents many problems which need to be solved. While dry wheat containing 12 to 13 per cent moisture may be safely stored in any type of bin which will protect it from the weather and insects, the storage of damp wheat is a more difficult problem.

The use of the combined harvester-thresher has magnified the wheat storage problem. In a state like Kansas where this machine dominates the harvest, the problem has become acute. Wheat which formerly was left in the shock and stack until later in the season, now is ready for the market during the first two or three weeks of harvest. During dry years this wheat can be piled upon the ground, for a time at least, without serious loss. But records show that about one year out of five is likely to be a damp wheat year. Under these conditions the losses due to damaged wheat are likely to be great, and with the combine in use there is likely to be a considerable quantity of damp wheat harvested each year. The wheat belt gets excited as the harvest season approaches. There is a thrill which comes with the broad expanse of golden grain waving in the sunlight, which comes with no other crop. With large acreages to harvest with each machine, it is natural to try to get started as soon as the grain will thresh. Under these conditions the first wheat from the combine is nearly always high in moisture content.

There has been a considerable amount of investigational work done on the drying of grain, but it is doubtful whether the construction of a really successful grain-drying plant would aid the wheat farmer of the Great Plains region. Since damp wheat occurs at intervals of several years, there is little incentive for the farmer to build and maintain expensive equipment for drying. Handling damp wheat will have to be solved by the use of equipment used each year in the handling of the normal crop.

The experimental work on wheat storage which was undertaken during the past summer (1929) was intended to determine the effect of different types of farm storage upon the quality of wheat. It was a cooperative experiment between the departments of agricultural economics, milling industry, and agricultural engineering of Kansas State Agricultural College. R. M. Green of the department of agricultural economics had studied farm storage of wheat in southwestern Kansas several years before and had concluded that certain types of grain bins were keeping wheat in much better condition than others. Dr. C. O. Swanson of the milling industry department was primarily interested in the effects of storage upon the milling and baking qualities of wheat. The experiment was located at the Fort Hays Experiment Station in the heart of the wheat-growing section of Kansas. Part of this station's 25,000 bushels of wheat were stored in the experimental bins.

Equipment Used. Eleven grain bins of approximately 500 bushels capacity were secured and erected upon the experiment station grounds. These bins were loaned or given to the college for use in the experiments. The bins included two wooden bins of the design widely broadcast by the National Lumber Manufacturers' Association. One of these bins was lined with Celotex furnished by the Celotex Company. There were also three concrete bins, two of concrete stave type similar to silo construction, and one square bin made of concrete boards with a wall 5 inches thick. There were six steel bins, two of which, furnished by the Martin Steel Products Company, had ventilated side walls and a large central ventilating flue, on top of which was mounted a suction cupola. The other four were tight wall steel bins of the type very commonly used in Kansas.

Six of the bins were filled with a John Deere tubular grain elevator and arranged alongside an ear corn drag conveyor which pulled the wheat back to the elevator to be re-elevated into another bin. The other five bins were filled by a blower elevator operated by a 5-hp. motor. This blower had a special attachment by which wheat could be taken from one bin and blown over into another.

The bins were equipped with a system of resistance thermometers, four or five in each bin, so that interior temperatures of the wheat could be quickly and easily read. From the meteorological data which is taken at the station there was available wind velocity and direction, temperature and humidity readings. A Brown-Duval moisture determination apparatus was set up at the station so that moisture determinations could be quickly run and the results known. Composite samples for moisture determinations were taken from each load of wheat and from the bins each time the wheat was moved from one bin to another.

At the time the bins were filled samples of wheat were placed in porous sacks and buried in the bins. When the wheat was moved these sacks accompanied the wheat to the new bin. These sacks of wheat, together with additional samples taken at the beginning and end, furnish the basis for the milling and baking tests. These samples were also judged by the federal grain inspection department to be graded as market wheat.

It was our intention to fill ten bins with damp wheat, wheat that would furnish a storage problem. But when the harvest got under way the weather was hot and dry and the wheat dried out so rapidly that we soon had no damp wheat available. There was enough damp wheat, however, to enable us to get considerable data.

Since the experiment station furnished the wheat and did not care to lose much wheat by damage, the wheat was moved and cooled whenever a dangerous temperature was reached. This temperature was thought to be 45 degrees Centigrade (or around 115 Fahrenheit) and so whenever the wheat temperatures approached 45 degrees in any part of the bin the wheat was moved. By following this system we avoided the loss of any wheat, since in none of the bins was there any seriously damaged wheat when on September 29 the wheat was removed from all the bins and stored in the station elevator. We should have liked to permit a bin or two to go to limit of heating and damage, but lack of funds did not permit us to waste that much wheat.

Some Results. The results as we have found them show to the disadvantage of the concrete and tight-wall steel bins. The first wheat harvested was placed in the ventilated steel bin which had a large central flue and a suction cupola on top. This wheat averaged 16.0 per cent moisture including one load which contained 18.0 per cent. The temperature of the wheat was about 24 degrees (Centigrade) when placed in the bin, and this temperature showed a gradual decline to about 20 degrees when it was re-

[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, Chicago, December 1929.

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moved in September. This wheat was not moved because it did not heat, and the grain appeared to be in perfect condition at the end. There was no spoiled wheat in any part of the bin.

A few days later we filled the concrete bin with wheat of an average moisture content of 16.2 per cent, in which one load contained 18.6 per cent. This wheat was hotter when it went into the bin, averaging about 40 degrees. In five days it had reached 50 degrees in one portion of the bin, and the entire contents of the bin was in critical condition. This wheat would have been a total loss if left undisturbed. It was caked so hard that it would stand up vertically in the bin and had an odor resembling fermenting silage. The weather at this time was very cool, and it was interesting to note that the wheat within eight inches of the wall was cool. It was also very wet as though some condensation was taking place on the cool wheat. This wheat was moved by a blower elevator over into a steel bin and then returned to the same bin. This moving cooled it down to 32 degrees from where it increased gradually up to 48 degrees twenty days later. It was moved a total of six times during the summer, with the result of lowering the moisture content to 14.0 per cent. The wheat was graded as No. 1, although there still lingered a slight sour odor due to the early heating.

Causes of Heating. It might be well to digress at this point and review the causes of heating in stored grain. This is a point that seems to be rather imperfectly understood although the principles seem to be fairly well established. Wheat is not a mass of inert material, but rather a number of living, breathing organisms. The release of heat energy by the grain is caused by respiration or breathing. Respiration has been defined as the release of energy by the oxidation of certain organic compounds, resulting in the formation of carbon dioxide and water. Most of the evidence seems to indicate that the heat of respiration is produced by the oxidation of the sugar within the embryo of the wheat kernel. This embryo is the only part of the kernel which shrivels with age, and when respiration ceases, the germ is dead.

Respiration speeds up as the moisture content of the grain increases, but the rate of increase is not uniform. Below 15 per cent moisture content, the rate of respiration is fairly low, but it is three times as rapid at 16 per cent as at 15 per cent, and twelve times as rapid at 17 per cent as it is at 15 per cent. This apparent increase in the rate of respiration when the moisture content goes above 15 per cent explains why 15 per cent is often given as the danger point for the moisture content of combined wheat.

The temperature of the wheat also has a tremendous influence upon the rate of respiration. The rate of respiration increases with the rise in temperature, slowly at first, but after 35 degrees is reached it increases more rapidly and jumps very rapidly from 45 to 50 degrees. At temperatures above 55 degrees the wheat is burned, the germ killed and the respiration stopped. In our grain bins we have the possibility of the combination of high moisture content and temperature together with consequent rapid heating. The so-called sweating of grain which everyone has witnessed is probably nothing more than the outward evidence of rapid respiration under conditions where the moisture cannot be removed as rapidly as it is formed. If dry wheat is stored in a bin it does not go through the sweat because the rate of respiration is very low.

Ventilated Bins Heated Less. In view of these fundamental causes of heating of stored grain our experiences during the past summer seem to be entirely reasonable. In every case the tight-walled bins seemed to heat more than those with ventilation. The wooden bins also seemed to keep the grain in better condition than the steel or concrete, although no excessively damp wheat was stored in them. The case of the insulated bin is interesting because of the uniformity of the temperature of the wheat. Wheat put in the bin at an average moisture content of 14.4 and a temperature of 35 degrees was still at 33 degrees on September 1 and had not heated at all. Wheat of a similar moisture content stored in the square concrete bin at 36 degrees had to be moved twice to prevent damage and was still at 38 degrees on September 1. It is our opinion that insulation may be a valuable factor in preventing wheat damage. The heat of the sun in August shining upon the steel bins seems to be a definite aid in starting the heating action.

Several types of ventilation flues of the kind in common use were tried out. One which has been sold in considerable number is a perforated steel tube 4 inches in diameter with a smaller pasteboard tube inside. The theory of this ventilator is that a circulation would be set up by the heat of the grain which would have a drying and cooling effect. We could not detect the slightest beneficial effect of these flues. In fact, they seemed to be damaging, because invariably there was an area of excessively damp grain around the ventilation flue. The same thing was true of the small central ventilator which is furnished with the steel bins. Around this small central flue there was always an area of wetter grain than anywhere else in the bin. If the wheat was moved frequently, this wet area around the flue was broken up and distributed throughout the other parts of the grain. When, however, the grain was left undisturbed for several weeks, this area around the ventilation flue became badly molded.

Our experiments seem to indicate that well-ventilated steel bins are much safer than tight-wall steel bins for the storage of damp wheat. It may also be that the ventilated wooden bin is a better type than any of the others. To store damp wheat safely in concrete bins, the farmer must be able to move the wheat in order to cool and dry it. In damp wheat years wheat stored in any kind of a bin is likely to need moving.

Based upon the movement of 16 bins of wheat during the past summer, it seems that the temperature of the wheat can be lowered about two-thirds of the difference between the wheat temperature and air temperature. Pick out a cool day on which to move the wheat. Reducing the moisture content by moving is slow work. On one bin six movements reduced the moisture content by 2 per cent. The difficulty in measuring the drying effect of moving is that different samples of wheat show a greater variation than the drying effect of moving. It is only by the effect of several moves that we can notice the effect.

The present plans are to repeat experiments next year with some mechanism developed to put the same kind and condition of wheat in each bin. A truer comparison can then be made.

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Structures for Farm Storage of Wheat[1]

By H. M. Bainer[2]

WITH the grain situation as it is today, I do not know of anything connected with wheat growing that is more important than more farm storage of the right kind. Statistics show a great deal of farm storage space available, but a large proportion of it does not meet present-day requirements. In Kansas, for example, the assessors reports for 1928 show a farm storage capacity, for the entire state, of 152,686,000 bushels. If this space was of the right kind and was all available for wheat, there would be sufficient capacity for an average crop and no additional space would be needed. But a large part of this space is not available for wheat; it is in use for seed, feed, shelled corn, kafir, oats, etc. In fact, very little of it is suitable for "combined" wheat. Very often combined wheat would be better off, piled on the ground, rather than in many of the bins included in the report.

[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, Chicago. December 1929.

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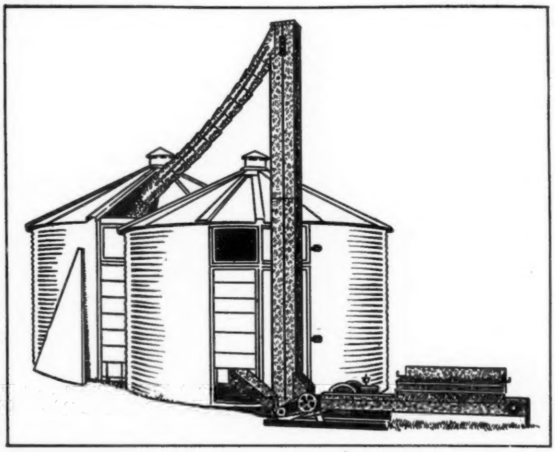
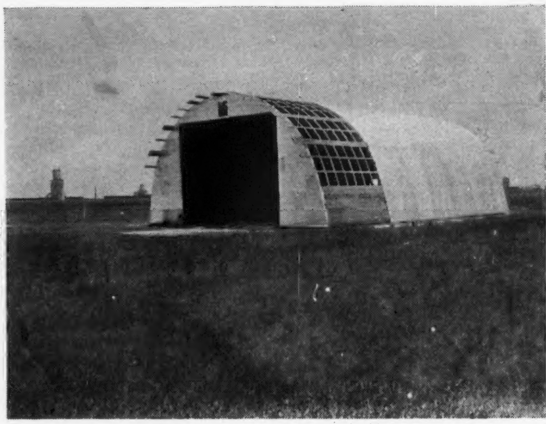


A three-purpose grain elevator suitable for unloading grain, turning it from bin to bin for curing or loading into trucks for hauling to market. It is adapted to outside use in connection with metal tanks, as shown, or to any other type of granary or farm storage unit

Combine is Responsible. The "combine" has revolutionized wheat harvesting and is compelling the farmer to make radical changes in his storage and marketing methods. The present plan, that of delivering a large part of the crop direct from the field to the market, results in a mad rush for space to unload and makes it impossible for local elevators and railroads to get the grain out of the way fast enough. As a result the farmer who does not have storage space is forced to dump at least part of his wheat on the ground. This rush plan has the temporary effect of overloading the market. It offers very little opportunity to sell wheat according to its real value, the tendency being to sell all of it at the same price, regardless of quality.

Whether or not it pays to store wheat on the farm, the combine has brought about a condition where a certain amount of it must be done. With 20,000 combines in Kansas this past season, for example, there was a sufficient number to harvest three-fourths of the state acreage in three weeks time. On basis of the 1929 crop yield, this number of combines harvested fully 100,000,000 bushels of the Kansas crop, making this much wheat available for the market by July 20. The combine method of harvesting is making as much grain available in three weeks as was formerly available in eight to ten weeks. And the result of this condition has made it impossible for any marketing system to handle the entire wheat crop during the time it is being harvested.

The Storage Quality Lowered. Before the days of the combine, when all wheat was cut with a binder or header and was shocked or stacked, the grain had time to cure before it was threshed. The combine has eliminated this curing process and any excess moisture in the grain at the time it is harvested goes with it to the bin or



(Left) An incomplete hangar-type shed, 36 by 50 feet, showing framework. (Right) Interior of a hangar-type shed, showing wheat-farming machinery in place

market. Then, too, combine wheat does not go through the "sweat" until after it has been placed in storage, thus adding to the dangers of heating and spoiling.

Statistics show that more heat-damaged and moldy grain comes through the improper use of the combine than through any other method of harvesting. This is largely due to the farmer being in a hurry to harvest, starting before the grain is mature enough or when it is damp from dew or rain. Then, too, during the first few days of cutting, there are green patches in and around the edges of fields, and if this wheat is permitted to go in with the dry or mature grain, it is likely to add enough moisture to cause all of it to heat. Cutting green weeds in grain will meet with the same objection as cutting green or wet grain.

The only place to properly cure combine wheat is in the field before the grain has been harvested. Wait until the crop is mature before beginning to harvest it, or cut it with a binder or swather. Let the dew dry off before starting the combine in the morning. Wait long enough after a rain or wet spell for the grain to become thoroughly dry. For best results green patches as well as weedy wheat should be cut with a binder or swather and should be cured before threshing. Keep wheat from green patches as well as weedy wheat by itself. Do not mix wet wheat with dry wheat. One load of wet wheat will lower the quality and grade of a bin full of dry wheat.

Proper Farm Storage the Solution. It is generally recognized that without additional farm storage no successful system of cooperative marketing, orderly marketing or farm relief measure can be properly developed. The present plan of overloading the elevators and railroad facilities is unsatisfactory, and wheat farmers in general are dissatisfied with it and are looking for relief. They realize that they cannot afford to pile wheat on the ground and that additional farm storage of the right kind is not only necessary but will insure more efficient returns. Increased farm storage of the wheat crop may be expected to give the following results:

1. It will help stabilize the wheat-growing industry.
2. It will assist in establishing a system of more orderly marketing.
3. It will make it possible for the country elevators to handle wheat in a satisfactory way.
4. It will help the car shortage problem.
5. It will overcome dumping wheat on the ground.
6. It will tend to prevent congestion of the July and August market, thus helping to stabilize prices.
7. It will spread the farmer's labor, income and marketing period over more time.
8. It will assist in getting the grain away from the combine or thresher more quickly and will make it possible for the farmer to harvest and market his crop without hiring much help.
9. It will make the farmer more independent and will enable him to use his own judgment in handling and selling his crop.
10. Above all, additional storage will provide a splendid opportunity to dispose of the crop at such prices as its protein content and other qualities justify.

Provision for Drying Stored Wheat. To store combined wheat in an ordinary bin or granary, without any provision for drying it, is risky. It is true that much combine wheat will be dry enough to store safely in almost any waterproof bin. But the fact that the moisture content of combined wheat may vary from one to three per cent during a single day's cutting, often makes storing of it questionable.

Thoroughly mature wheat, harvested too early in the morning, before the dew has dried off or too soon after a rain, may contain as much as 14 to 16 per cent moisture, while the same wheat harvested later the same day may not contain over 12½ to 13 per cent. This variation in moisture content makes storage in ordinary farm bins dangerous and proves that no type of storage should be considered that does not provide for proper ventilation or for moving the grain from one bin to another. Grain that contains only a slight excess of moisture may be stored in properly ventilated bins. But for storing slightly damp grain, provision must be made for moving it from one bin to another in case it begins to heat.

Anything that will cause wheat to heat in storage is a danger factor. Moisture content is the chief factor determining the fitness of grain for storage. In general, the chief heat-producing factors are excessive moisture, weevil, dirt, weed seed, and grain going through the "sweat."

Very little definite information, covering results or factors affecting wheat storage, is available, especially from the farmers' standpoint. The following general information is the result of a questionnaire recently sent out to managers of terminal elevators and others interested in storing wheat on a large scale and applies to large volume storage. The following summary is the result of thirteen replies:

1. A moisture content of 12 to 13 per cent is considered safe for storing wheat, and above 13.5 per cent is considered dangerous.
2. A temperature up to 100 degrees (Fahrenheit) is considered safe for storing wheat, especially if the moisture content is satisfactory, and a temperature between 110 and 120 degrees is considered dangerous. In-

crease of temperature, above the point recognized as safe, is considered a warning that the grain requires immediate attention.

3. It was generally agreed that a temperature of 110 to 120 degrees, even for a short time, is sufficient for "skin burning" and if allowed to continue long enough will cause "bin burnt" or "heat damaged" wheat.

4. Summer heat in stored wheat is not considered dangerous, providing the wheat does not contain excessive moisture or weevil infestation. But a high temperature is favorable to weevil development and to heating, if there is any excessive moisture.

5. All agreed that weevil infestation is one of the leading causes for heating in wheat. Weevil heating is usually confined to pockets or spots, where they accumulate and develop, and not to an entire tank of grain. The most favorable temperature for weevil development is from 80 to 90 degrees and is controlled almost entirely at 60 degrees and below.

6. Stored wheat should be moved every 45 to 90 days whether or not it shows any signs of heating, and oftener if it contains excessive moisture or weevil. For long-time storage wheat should be cooled to 40 degrees or below.

7. Stored wheat should be watched while going through the "sweat" as it is likely to heat.

8. The manner of moving has more to do with the keeping qualities of wheat than the number of times it is moved. The more moving wheat can be brought in contact with the air, the better.

9. It was generally agreed that wheat could be as safely stored on farms as in terminal elevators, provided the granaries or bins are in good condition and the wheat can be ventilated or moved.

10. Wood was considered the best material for construction of farm storage units with tile and concrete second and steel third.

More Permanent Storage Needed. While no wet wheat should be stored, there are times when it may be necessary to store grain that is slightly damp. There will always be years of dry harvests and dry grain when almost any kind of a bin or tank wil provide satisfactory storage. But some of the combine wheat, even of the dry years, will bear watching as it may carry too much moisture for safe storing. On the other hand, there will always be years of wet harvests and damp grain when storage conditions will be very unfavorable.

The illustrations accompanying this paper show practical plans of farm storage that will meet with present-day requirements. It makes very little difference in the keeping qualities of grain, whether the materials used to make farm storage is wood, concrete, tile or steel, provided the system for ventilation or rehandling is of the right type.

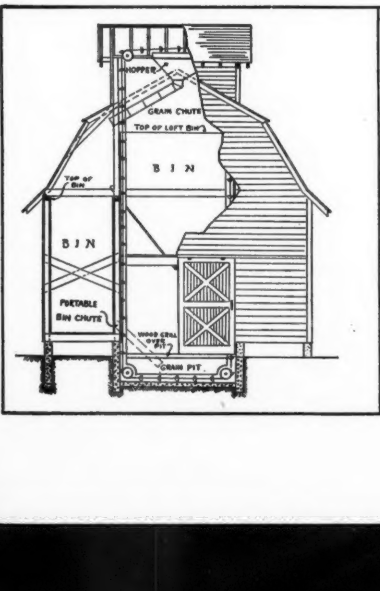
While well-ventilated bins will often recondition slightly damp wheat, it is risky and dangerous because the average farmer only guesses as to the degree of dampness. If the wheat he stores happens to be too damp, no system of ventilation will reduce the moisture quick enough to prevent damage.

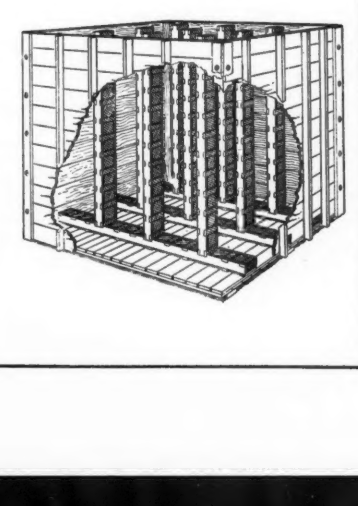
The safest and most practical way of storing wheat, therefore, is through the use of farm storage units, such as is shown by the accompanying illustrations, which provides for rehandling the grain. In this type of storage the grain can be dried and cooled by moving from one bin to another or from one pile to another. The number of times necessary to rehandle wheat in order to dry it depends on the amount of excess moisture in it. Ordinarily two or three times will be sufficient, but if there is considerable dampness it may have to be moved more times.

Hangar-Type Storage Shed. During the past year or two several large round top hangar-type sheds have been constructed in the southwestern hard winter wheat territory. These are being used as combination storage for wheat and wheat-farming machinery. They are of the half-round balloon type, anchored to concrete foundations, without floors or inside supports, as shown by the accompanying illustration. The rafters are placed two feet apart and are made of one-by-fours, four in thickness, nailed together in a half circle over a form. The cross pieces or stays are one-by-sixes placed from 12 to 18 inches apart, and the roof covering is channel drain iron, 28 gage being quite generally used. These sheds are usually built in widths of 32 or 36 feet so that an end door can be made large enough for a combine to enter. They can be built any length desired.

During the harvesting season, when the wheat-farming machinery is in the field, the shed provides an excellent place to pile the wheat where it is protected. If the wheat needs moving, it is an easy matter to do it with a portable farm elevator, moving it from one pile to another. Sheds of this type are comparatively inexpensive and serve two purposes. One now in use on the Chester I. Long farm of Fowler, Kansas, is 40 feet wide, 180 feet long and 20 feet high in the center and has a capacity of 20,000 bushels. Some old lumber was used in its construction and the cost was figured approximately at $1300.

A shed of this type at Ashland, Kansas, 36 by 90 feet and 18 feet high in the center, exceptionally well constructed, cost $1200.00. Another one at Meade, 36 by 50 feet, cost $640.00 and one at Plains, 32 by 40 feet, cost $440.00. These prices include new material, carpenter work and everything. A shed 36 by 50 feet will house the wheat-farming machinery on an average farm, and when the machinery is removed it will provide storage space for 3500 to 4000 bushels of wheat. There is no question but that this new type of storage is economical and practical and will be used more generally in the future in the wheat belt of the Southwest as well as in other parts of the country.





(Extreme left) A modern six-bin storage unit of eight to ten thousand bushel capacity. (Left) A good system of ventilation for grain bins. Ventilators measure 4 by 6 inches, outside dimensions, are made of one-inch lumber and covered with galvanized fly screen, as shown, and are spaced three feet apart each way. The horizontal ventilators have outside openings for providing a good circulation of air

An Experiment in Teaching Farm Structures[1]

By Deane G. Carter[2] and C. E. Prall[3]

A STUDY of methods of teaching farm structures was carried on during the spring semester, 1928-29, at the University of Arkansas. Twenty students under the direction of one of the authors (Carter) and thirty-one students at cooperating institutions were involved in the study. Most of the men were agricultural students in the junior and senior years.

The principal objective of the study was to determine if "an inductive formulation of principles, developed by a study of requirements, of limitations, and by the solution of typical building problems" represented a better method of teaching than the usual textbook recitation and lecture procedure.

At the University of Arkansas, the course was divided into four units; Barns, farm houses, poultry houses and storage buildings. The first and third units were presented by the experimental method, while the second and fourth units were given by textbook assignments and lectures elaborating general principles. The same amount of time in the semester was allotted to each type of teaching.

In the cooperating colleges no restrictions were placed on the time allotted to each subject, nor were any variations in method reported. In general it is believed that the time allotment for each of these units on various campuses did not greatly differ. The examinations in the cooperative colleges were given when the students had finished the subject matter in question. The scores of the students in the other colleges were used to establish a standard score on each test under the prevailing or usual method of teaching each unit.

In the experimental units emphasis was placed on the problem to be solved, leading to a bringing together of principles and essential facts involved in the solution. In the control units the approach was topical, with greater masses of fact data.

The criteria for determining the results consisted of two objective examinations over each unit. One of the examinations was designed to measure the student's ability to apply principles to new and concrete situations. Theoretically at least, this test proposed to measure the application of knowledge rather than the mere acquisition of facts. The other test covered a wide range of informational or factual material; in nature a sampling of the whole field of the subject matter worth learning and not confined specifically to the topics covered in class.

It was thought that the relative standing of the local class on the first or "principles" test covering the experimental units would show something ot the effectiveness of the changed method of teaching. A high score on the principles test over a given unit, with an average or ordinary score on the fact test, would be indicative of the superiority of the experimental method in the application of principles, but would not indicate that the differences were due wholly to differences in the abilities of the students or in the teacher's general efficiency.

On account of limited time not all of the tests could be given by the cooperating colleges. However, on the experimental units the Arkansas students made significantly higher scores on the "principles" tests. On the factual material or information tests there were no significant differences.

[1]Research Paper No. 158, Journal Series, University of Arkansas. Released for first publication in AGRICULTURAL ENGINEERING.

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[3]Dean of the College of Education, University of Arkansas, formerly research professor of education.

Based upon this single study the tentative conclusion is that the experimental attack did contribute to the development of ability to meet situaions and apply principles more effectively than did the prevailing method. It also indicated that there is less overlap between purely informational outcomes and ability to apply principles to new situations than is generally recognized.

The following tabulation gives the results of the test on the first experimental unit:

Tests on "Barns"

	Cases	Perfect score	Arkansas average	Cooperating colleges
Principles	51	40	22.8	17.05
Facts	50	50	29.3	29270

It will be noted that the Arkansas average is approximately 5.8 points higher on the principles test than is the average of the students in the cooperating colleges. It will also be noted that on the fact test the Arkansas average is below the average of the students in the cooperating schools, although this amount is not very large. The extent to which the Arkansas average on the first test was significantly higher than the others may be judged from the fact that this average was almost a whole standard deviation above the average obtained when all of the students taking the test were thrown together. A difference this large is generally considered to be very significant.

Following are several typical fact questions from the test on the barn unit and a single question from the "principles" test, to compare the difference in method of approach, exercise of judgment, and need for memorized fact in each case:

FACT TEST

What space is required for one horse in a tie stall?............

What is the cubic volume required for one ton of loose hay? ....

On what radius would the curve of the gothic roof barn be made for a 36-foot span?..

What are the approximate angles for the upper and lower gambrel roof rafters? ....

What is the necessary dimension for a driveway through the barn? ....

How would you calculate the exact height of each riser in a stair to the loft, if the total difference between floors is 9 feet, 9 inches? ....

PRINCIPLES TEST

Question. Here is a barn plan in a semi-finished condition. Indicate in the spaces below (a) the major errors of planning, and (b) other mistakes in planning.

Answer.

A. The major errors in planning are
  1. The barn is larger than necessary for this number of animals.
  2. The pen and storage space is out of porportion to the number of animals housed.

B. Other mistakes in planning are
  1. Feed way is too narrow.
  2. No outside door to horse box stall.
  3. Not desirable to take animals from horse box stall through feeding alley.
  4. Harness room door should be at rear of stalls, or there should be two doors.
  5. There is unused space beneath stairs; it might be included in feed room.
  6. Left fed room wall should show thickness for studs and covering.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Report of Proceedings of Conference on Electricity Supply in Rural Areas, H. E. Haward, D. Newton, J. T. H. Legge, et al. (London: Electricity Commission, 1928, pp. 84).—These proceedings consist mainly of reports by two subcommittees and considerable appended data.

The first subcommittee draws the striking conclusion that much uncertainty attaches to any generalizations as to potential demand which are based entirely or mainly on results obtained or shown to be possible in particular areas. Short of a preliminary survey of the possibilities in a number of typical unsupplied districts, it appears to the subcommittee that there are considerable difficulties in the way of arriving at any reliable forecast of the potential demand for electricity during the course of the next 10 years in the rural districts of Great Britain taken as a whole.

It is evident that for economic reasons rural electrification can not be proceeded with to the extent of placing a supply of electricity at the service of every inhabitant, farm and other premises throughout rural Britain. There is no doubt that the prospects in the sparsest and most remote areas are of such a low order as to preclude, or at any rate delay for many years to come, the establishment of a public supply on a remunerative basis even under the most favorable conditions of capital expenditure on rural distribution. It has been variously estimated that up to 50 per cent of the more sparsely populated rural portions of the country is likely to fall within this category.

For the power requirements on the average farm a 5-horsepower electric motor is usually found to be ample. If supplied by means of a flexible cable and mounted on a wheeled bearer the motor can be moved from point to point and coupled by a belt to different machines as desired. In many cases, however, farmers are found to prefer an installation of several motors, ranging from 1 to 5 horsepower, fixed for separate duties in the farm buildings although this entails a greater initial cost both for wiring and motors. A motor of about 15 horsepower is normally required for threshing purposes or of about 20 horsepower for threshing and binding; but on many of the smaller farms the threshing is carried out by a traveling steam plant which is hired for the ncessary period.

The subcommittee is definitely of the view that the success of rural electrification is essentially dependent upon the provision of the best possible facilities in the way of assisted wiring schemes, and the hire and hire-purchase of apparatus for all classes of consumers.

The Spontaneous Combustion of Hay, C. A. Browne (U. S. Department of Agriculture, Technical Bulletin 141 (1929), pp. 39, figs. 8).—This bulletin contains a review of previous theories as to the cause of the spontaneous combustion of hay, indicating a wide divergence of opinions, and gives new suggestions in an effort to develop a tenable theory based on experiments by this department and other agencies.

The theory of the spontaneous heating and ignition of large masses of hay proposed is based upon the preliminary production by microorganisms under more or less perfect anaerobic conditions of unsaturated, highly unstable, intermediate-fermentation products upon the surfaces of the porous, cellular materials. The duration of existence of these readily oxidizable fermentation products is dependent upon the quantity of air that can gain access to the fermenting mass of hay, and also upon the quantity of moisture which is present to serve as a reacting medium. If the heaps are small or of open, loose structure, the intermediary compounds are destroyed almost as soon as formed, with the result that when vegetative microorganic life is all destroyed at 70 to 80 degrees (Centigrade), there is not a sufficient residue of such easily oxidizable, unsaturated substances to carry the production of heat to higher limits The heat of the microbial life period is probably owing in large part to the oxidation of the same intermediary unstable products that participate in the elevation of temperature above 80 degrees. The microorganisms simply produce the highly unstable compounds whose subsequent oxidation generates the increasing quantities of heat that lead first to the destruction of the organisms themselves and then eventually to the ignition of the hay.

It has been found possible to duplicate in the laboratory some of the conditions existing in a hay pile for the formation of such unsaturated compounds, and, by adopting suitable means for preventing access of oxygen, to effect their separation and identification.

In pointing out the need for further investigation in the subject it is stated that "the answer to the problem can be obtained only by extensive cooperative experiments by chemists, bacteriologists and engineers upon the changes that take place in large piles of fermenting hay. The piles must be sufficiently large (5 tons or more) to furnish the retention of heat and insulation that are necessary to produce spontaneous ignition of the hay.

"In observing the changes that take place in large piles of fermenting hay, and developing methods for the prevention of spontaneous heating and ignition, investigators must give special attention to the following factors: The rate of heat production in different parts of the mass of material. The changes in chemical composition of the hay. The oxygen-consuming power of fresh and fermented hay and of extracts from the same. The migration of moisture from the warmer to the cooler parts of the stack. The production of gases in different parts of the pile. The effect of the entrance of outside air at various stages of storage upon producing an increase of temperature in different parts of the pile. A study of the condition existing in the areas of highest heat production. The effect of various methods of curing the hay. The effect of the addition to the hay of salt and other substances. The employment of ventilating flues and other devices."

A bibliography is included.

Electrical Statistics for California Farms, B. D. Moses, California Station (Berkeley) Circular 316 (1929), pp. 20, figs. 7).—This bulletin is a contribution from the station and the California Committee on the Relation of Electricity to Agriculture. It presents statistics on the uses of electricity in California agriculture. The data show that the California farmer already uses electricity extensively and that the trend is upward. They also show that the heaviest farm load occurs in the summertime, that the peak appears in July or August, and the valley in January, and that over 50 per cent of the energy used for power purposes is consumed during the months of June, July, August and September.

Electric Hay Hoists, F. E. Price, A. W. Oliver and E. L. Potter (Oregon Station (Corvallis) Bulletin 255 (1929), pp. 16, figs. 9).—The results are presented of experimental work on hay hoists, which was conducted by the station in cooperation with the Oregon Committee on Electricity in Agriculture.

It has been found that a good power hoist will operate satisfactorily with either fork or slings and can be operated conveniently and satisfacorily by a man on a wagon. It replaces the pull-up team and driver, and makes the use of a gravity pull-back for the fork convenient and practical as the brake will stop or slow up the carriage or fork at any place. A little time is also saved in starting, stopping and setting the fork, and the use of a larger fork than can be easily set by hand is made possible since the fork can be put in position on the load largely by the aid of the hoist. The hoist will not elevate the hay faster or in larger loads than is possible with horses without danger of breakage to the carriage or tracks.

It was found that a power hoist uses ⅓ kilowatt-hour per ton of hay hoisted, and the power costs 1 cent per ton at a rate of 3 cents per kilowatt-hour. One horsepower is required for each 135 to 150 pounds of load at a hoisting speed of 125 feet per minute.

On the Joint Influence of Iron and Aluminium in Native Sands on Mortar Strength, H. W. Leavitt, J. W. Gowen and L. C. Jenness (National Academy of Science (Washington, D. C.) Proceedings, 15 (1929), No. 9, pp. 742, 743, figs. 1).—Studies conducted at the Maine Technology Experiment Station are reported. The results presented furnish proof of the fact that iron and aluminum jointly and separately materially influence the strength developed by mortars made from native Maine sands. It is also concluded that the chemical condition of the sand used in cement mortars materially influences the strength of these mortars when hardened. Proof is thus furnished of the chemical interaction of the sand and the cement.

The Mechanics of Shear Failures on Clay Slopes and the Creep of Retaining Walls, C. Terzaghi (U. S. Department of Agriculture, Public Roads, 10 (1929), No. 10, pp. 177-192, figs. 21).—A digest of the published data concerning friction and cohesion of clay soils is presented which discloses the fact that the angle of internal friction of such soils is exceedingly small as compared with the slopes cf cuts and fills. Hence, the stability of all clay fills and clay cuts depends essentially on cohesion. Due to this fundamental fact, the factor of safety of slopes with a given inclination rapidly decreases

beyond the critical height at which the soil can stand with a vertical face. Hence, a stable fill of a certain height and consisting of a certain clay soil is no indication of stability in a fill of twice that height, with the same slope and consisting of the same material. In computing the factor of safety of a cut or fill the curvature of the sliding surface must be taken into account, else the results of the computation may be very misleading.

A graphical procedure is presented which furnishes the means of making stability computations rapidly. The figures furnished by the computation of the stability of retaining walls only inform about the stability of the walls with regard to the forces produced by the inert weight of the back fill. There exists the possibility of the occurrence of forces which tend to press the wall gradually out of its original position and which are entirely independent of the active earth pressure. No relation seems to exist between these forces and the active earth pressure of the back fill. The intensity of the active earth pressure depends on the unit weight, the internal friction, and the cohesion of the back fill, while the forces which tend to displace the wall gradually depend on the elastic properties of the back fill, its structure, and on the climatic conditions. The current practice for considering the existence of these nongravitational forces consists in computing the retaining walls as if cohesion were nonexistent. Due to the absence of any causal relation between the active earth pressure and the nongravitational forces, this practice, under favorable conditions, leads to structures with an excessive factor of safety and which are uneconomical. On the other hand, under favorable soil and climatic conditions the walls are apt to gradually yield in spite of the apparent additional safety obtained by neglecting cohesion. In order to reduce the uncertainty associated with the design of retaining walls and abutments, a systematic investigation of existing retaining walls and abutments is considered highly desirable.

Data on Ultra-Violet Solar Radiation and the Solarization of Window Materials, W. W. Coblentz and R. Stair ([U. S.] Bureau of Standards Journal of Research, 3 (1929), No. 5, pp. 629-689, figs. 23).—This paper deals with (1) the amount of ultra-violet in solar radiation of wave lengths less than about 310 mu, found to be of especial use in preventing rickets, but shut out by common window glass, (2) the decrease in transmission that ocurs in the newly developed window glasses for transmitting ultra-violet of wave length less than about 310 mu, when exposed to ultra-violet radiation, and (3) the proper use of windows in order to obtain the most effective therapeutic results.

By four methods of attack, data were obtained showing that the upper limit of the total amount of ultra-violet solar radiation, of wave lengths less than about 310 mu, is less than 0.004 g. cal./cm^2./min. at sea-level stations.

It is shown that nearly all these newly developed window glasses decrease in transmission, especially in the ultra-violet of wave lengths less than 310 mu, when exposed to the sun and to artificial sources containing ultra-violet radiation. In some makes of glass there is practically no decrease in transmission as the result of photochemical aging; other glasses lose almost one-half their transparency at 302 mu in the process of photochemical stabilization. Concerning the use of windows, data are given showing that, with variation of the angle of incidence of the solar rays from normal upon the solarium, during the year and during the day, the amount transmitted through the glass decreases by about 20 per cent. The necessity of keeping the glasses clean is indicated by the observations that dust and dirt reduce the transmission at 302 mu by 30 to 40 per cent.

Double thickness (0.25 inches, 6 millimeter) wired glass, even when made of these newly developed materials (except, perhaps, Corex-D and pure quartz glass) after complete photochemical stabilization, transmits only 3 to 5 per cent at 302 mu, which is probably too low for therapeutic use. Hence, a glass of single thickness (2.5 millimeter), with a wire mesh under it for safety from breakage, is recommended for solarium roofs.

A bibliography is included.

Farm Machinery and Equipment, H. P Smith (New York and London: McGraw-Hill Book Co., 1929, pp. XII+448, figs. 554). —This book represents the fruits of several years' study and experimentation by the author with various types of farm machinery and mechanical equipment at the Agricultural and Mechanical College of Texas and the Texas Experiment Station. It covers the most important types of machines used in present-day general farming, and opens with a comprehensive discussion of the more important phases of physics and engineering mechanics involved in the analysis of the design, operation and adjustment of these machines.

The main part of the book is devoted to the design, construction, operation and efficiency of the various types of farm machines, special attention being given to plows and other tillage implements because of their universal importance in seedbed preparation.

Machinery used in the growing, harvesting and preparation of cotton for the market is given special attention also, and the combine is thoroughly covered. Other chapters are included on seeding machinery, harvesting machinery, seed separation machinery, fertilizing machinery, transportation equipment, and cleaning and grading machinery.

The book marks a departure in the treatment of the subject in that it summarizes progress in research and development of technical knowledge relating to important machines and mechanical processes, thus making it useful not only as a text but as an engineering handbook.

The Mohave Desert Region, California, D. G. Thompson (U. S. Geological Survey, Water-Supply Paper 578 (1929), pp. XI + 759, pls. 34, figs. 20).—Following a preface by O. E. Meinzer, the results of a geographic, geologic and hydrologic reconnaissance of the Mohave Desert region of California are presented.

Industrial Refrigeration, Cold Storage, and Ice-Making, A. J. Wallis-Tayler, edited by R J. Cracknell (London: Crosby Lockwood & Son, 1929, 7 ed., rev. and enl., pp. XI + 776, figs. 523).—This is a practical treatise on the subject which includes chapters on origin of artificial refrigeration, the theory and practice of mechanical refrigeration, the liquefaction process, the vacuum process, the compression process or system, condensers and water cooling and saving apparatus, the absorption and binary absorption process or system, the cold-air system, cocks, valves and pipe joints and unions, refrigeration and cold storage, marine refrigeration, refrigeration in dairies, manufacturing, industrial, and constructional applications, ice-making, the management and testing of refrigerating machinery, cost of working, the production of very low temperatures, the design of refrigerating machines, and household and small commercial plants.

Book Review

"The Air Seasoning of Wood," by J. S. Mathewson of the Forest Products Laboratory, is the most comprehensive and authentic presentation of the methods of air seasoning lumber, posts, poles, ties, timbers, and other forms of wood ever prepared. This publication is of value to manufacturers, fabricators and dealers in wood products. The methods developed are the result of nationwide studies by the Forest Service with the object of reducing degrade and other losses incurred during air seasoning.

This publication, now in the course of preparation, will be sent free to those requesting it as long as the supply lasts. Requests should be addressed to the Forest Products Laboratory, Madison, Wisconsin.

"Flood Waters of the Mississippi River" is published by the United States Government Printing Office as Senate Document No. 127. It is an engineering report prepared for the National Flood Commission by the Research Service, Inc., of Washington, D. C., covering the geology and hydrology of the problem, methods of controlling floods, navigation, power development and economic conditions. The booklet is indexed and contains an extensive bibliography of the subject.

"Handbuch der Landmaschinentechnic Vol I, Part 2" by Dr. George Kuehne (Mem. A.S.A.E.), professor of farm machinery at the Polytechnic University of Munich, Germany, has recently been published. Part 1 of this volume, published in 1928 and reviewed in the October, 1928 issue of AGRICULTURAL ENGINEERING, covered horse-drawn and cable-operated tillage machines. In part 2 the study of tillage machines is continued, covering engine-mounted plows, wheel and track-type tractors, implements for direct mounting, and rotary tillers. Some chapters are inculded on machines and implements for fertilizing, seeding, transplanting and cultivation. Part 2 contains page numbers from 133 to 353 and figures 314 to 888. The subject matter is treated in a technical way and is written for engineers and students rather than for the ordinary farmer.

"Designs for Kansas Farm Homes" by H. E. Wichers is published as Kansas State Agricultural College Bulletin, Vol. XIII, No. 10. The bulletin covers the value of planning, the farmstead as a building site, the farmhouse problem, the farmhouse exterior, and solutions for the farmstead problem. It includes elevations and floor plans for 39 farm house designs, and a bibliography on the subject.

"American Standards Yearbook, 1930," is a 104 page, paper-bound booklet issued by the American Standards Association and explaining its organization and activities. It contains a list of the officers of the Association; a general statement of its organization and methods of operation; the report of the president; detailed information on the four methods by which standards are developed; some typical projects of the Association; a statement of the value and types of industrial standards; membership regulations; the place of trade and technical associations in the standardization movement; government cooperation; international cooperation; publications of the Association; a list of projects suggested, under way, and completed; list of cooperating bodies, sustaining members and local representatives; statement of the administrative organization; copy of the constitution, by-laws and rules of procedure; financial statement of the Association and other useful information. Anyone wishing a copy of this book may obtain it free of charge by writing to the American Standards Association, 29 W. 39th Street, New York, N. Y.

Who's Who in Agricultural Engineering

R. W. Carpenter

J. T. McAlister

A. J. Schwantes

E. M. Mervine

R. W. Carpenter

Ray Wilford Carpenter (Assoc. Mem. A.S.A.E.), chairman of the North Atlantic Section of A.S.A.E., is professor of agricultural engineering at the University of Maryland. He entered the University of Nebraska in 1913 but went into military service before completing his course. Most of his time in the service was spent as instructor in aviation motors at the Great Lakes Naval Training Station. Returning to the University of Nebraska after the war, he graduated with a major in agricultural engineering in 1920 and was retained by his Alma Mater as assistant agricultural engineering extension specialist. In September of that year he took up his present work in charge of agricultural engineering at the University of Maryland. By attending evening classes at Georgetown University he earned a bachelor's degree in law by 1925. He has been affiliated with the Society since 1921 and he is particularly active in the North Atlantic Section.

J. T. McAlister

John Thomas McAlister (Mem. A.S.A.E.) is extension agricultural engineer at Clemson Agricultural College (South Carolina). After receiving his bachelor's degree in agriculture, having majored in agricultural engineering at Mississippi A. & M. College he served as instructor in the department of agricultural engineering there for about a year and then enlisted in the army. Following service as a private and later as a second lieutenant of field artillery during the World War he returned in 1920 to take up the instructorship he had left. The following year he was promoted to the rank of assistant professor and in 1922 left Mississippi to become assistant professor of farm machinery at Clemson Agricultural College. In 1923 he was promoted to associate professor in charge of agricultural engineering and held that position until 1928. Then he organized and was put in charge of agricultural engineering extension activities in the state, which position he holds at present. He helped organize the South Carolina Committee on the Relation of Electricity to Agriculture in 1926 and has since served as its secretary. During 1927 and 1928 he was also in charge of an investigation at the South Carolina Experiment Station, of the labor and power requirements for growing cotton. He has been a member of the Society since 1920 and was chairman of the Southern Section in 1927-1928.

A. J. Schwantes

Arthur J. Schwantes (Mem. A.S.A.E.) is associate professor in charge of the farm machinery section, division of agricultural engineering, University of Minnesota. In June, 1917, he received a diploma in agriculture from the University of Wisconsin, having majored in agricultural engineering. After traveling in extension work for three months with the Wisconsin land clearing train he demonstrated land clearing machinery for the A. J. Kirstin Company (stump pullers) until in July, 1918, he enlisted in the army, where he served as sergeant in a machine gun company. Later he spent several months as land clearing engineer at Walkill Farm, Green Cove Springs, Florida; and then returned to the Kirstin organization. In 1921 he went to the University of Minnesota as assistant professor of agricultural engineering in land clearing branch of the work. From then until 1927 he conducted research and extension work in the land clearing, had charge of the distribution for land clearing purposes of more than 10,000,000 pounds of surplus war explosives, wrote several bulletins and completed requirements for his bachelor's degree. In 1927 he was transferred to his present position in the farm machinery branch of the work. For the past semester he has been on leave of absence from the University of Minnesota and has been doing graduate work at the University of Wisconsin.

E. M. Mervine

Ernest Muchmore Mervine (Mem. A.S.A.E.) is professor of agricultural engineering in charge of instruction in farm power at Iowa State College. After receiving his M. E. degree at Lehigh University in 1909 he was initiated into agricultural engineering work in the experimental department of Deere & Company, where for three years he worked on the design, construction and testing and demonstration of tillage machinery and gasoline engines. In 1912 he left that position to become an assistant professor in the agricultural engineering department of the school at Ames. In 1913 he was promoted to the rank of associate professor and since 1923 has held his present position. When his department acquired a 160-acre farm a few years ago he was placed in charge of it, and in addition to accommodating the research and demonstration demands placed upon it, has operated it as a practical, profit-making farm and has collected valuable cost data covering the crops raised and operations performed with modern equipment.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Organization for Farming

EXTREME individualists, advocates of central management, and supporters of corporate organization are still waging their free-for-all of opinion on how farms should be organized and operated. The dust they are raising obscures the issues. Far be it from us to want to stop a good fight. But by way of clearing the air a bit so combatants and observers alike may take a fresh look at what it is all about we submit a review of some definitions and basic considerations.

Farming is an enterprise of production—the creation of primary, time, place, form and other utilities—in other words, the growing, sometimes the processing, and the marketing of domesticated plants and animals or their products. Production is accomplished by a working combination of land, labor, capital and management.

The individual family is the original economic unit—a natural result of its being the primary social unit. It enjoys the advantages of simplicity and independence. On the other hand, it is rarely able to command an efficient working combination of land, labor, capital and management. Its labor is wasted because it is poorly managed or is not provided good tools to work with. Or its managerial ability may be wasted on poor land or too few workers. Moreover, the scale of its operations is distinctly limited. The individual family farm is a holdover from the state of economic development in which 90 per cent or more of the population were farmers and each family largely self-sufficient. It does not follow that this is necessarily the ideal basis of farm production under the entirely different conditions which exist today.

As a matter of fact a gradual change to a more suitable basis of production has been going on for a long time. Specialization of function has been increasing. So has corporate organization. How far can these developments be profitably carried? That is the real issue.

Spinning, weaving, the making of clothes, and also the making of tools used to be farm jobs. Churning and cheese making in the farm home have largely given way to dairy manufacturing in the nearby town or city. As a farm trades off one after another of its functions for the advantage of being able to concentrate and specialize on the remainder, it loses its character as a farm and becomes a business,—a dairy, poultry, grain-growing, truck-gardening, nursery, fruit-growing or other business. Incidentally it becomes a field of opportunity for corporate operation.

Who dares say where this movement will stop? Will it ever stop? Not while there is progress. The realignment of economic functions is incident to advancement in the knowledge and technique of those functions, to market demands, supply conditions and other changing influences. It often necessitates a certain amount of social reorganization as well.

The professional management of groups of individual farms, on each of which the individual family is retained as the labor unit, as is being worked out in the corn belt, is undoubtedly a big step in modernizing farm production. It places on a trained, capable manager the responsibility of the major decisions as to how the land shall be handled, what crops and livestock shall be raised and what equipment shall be used. It introduces simple accounting, systematizes the work and retains the personal interest of the farm family in the work. It is a wise realignment of economic functions, a step away from independent individualism in farming, but not so big a step as corporation farming.

Opponents of corporation farms claim they mine the soil, do not give enough thought to social considerations of farm life and cannot secure the personal interest of laborers in the farm work. Corporations are man made. Some have been improperly organized, have been unwisely managed, have died inglorious deaths. But there is nothing inherent in corporate organization to encourage short-sightedness or to prevent the overcoming of specific problems such as providing incentives to labor. The opposite is true. Corporations have proven such a great boon to other industries that they deserve a fair trial in agriculture. There is much yet to be learned about corporation farming and mistakes will be made in the learning. The men who are risking their careers and fortunes to pioneer this development are true patriots.

The organization of farming or any other business is not an exact science. There is no formula by which the best form of organization to fit a particular business or situation can be found. Individual operation, group or central management, and corporate organization, along with a multitude of other debatable questions in farm management, will undoubtedly always have advocates who can point to their own success in support of their ideas. A little animated discussion of the advantages and disadvantages of the various forms of organization will do no harm and may do some good if not taken too seriously. Economic justification will determine their future.

Selected Opportunities

WHEN the Agricultural Marketing Act, legal foundation of the Federal Farm Board, was passed, we understood that it provided for a study of methods of expanding markets and of developing by-products. In the rush to apply the legal pulmotor to financially suffocating farms, these calisthenics for the health and up-building of agriculture seem to have been neglected.

The act is serving well as a demonstration in agricultural economics. It is shattering pipe dreams. It is showing up the limitations and weaknesses of price and production control. If only it could have embodied the debenture plan and the equalization fee, the disillusionment might have been complete.

If progress in production has more than caught up with market demands, the remedy is not to limit production but to extend the field and spirit of progress into marketing. If all farmers cannot keep up the pace of increasing production efficiency, the remedy is not to slow down the pace but to broaden the field of opportunity. Study of the possibility of expanding markets and of developing by-products is proceeding on a small scale with promising results. The power of the agricultural marketing act could profitably be used in support of such activities.

A. S. A. E. and Related Activities

Twenty-Fourth Annual Meeting Sets New Attendance Record

RENDEZVOUS of agricultural engineering's four hundred as literally that number streamed in from all points of the compass to attend the twenty-fourth annual meeting of the A.S.A.E., Moline's Le Claire Hotel and Elks' Club teemed with life from June 13 to 19. Gathered again to mount together new heights of vision and inspiration they were an enthusiastic, bouyant crowd. As friend met friend and as each newcomer dissolved in the throng, the many diverse interests of the individuals were submerged beneath a rising tide of consciousness of their common opportunity and purpose, the application of engineering in and for agriculture.

Before the meeting great promises were made; they materialized. F. A. Wirt's program committee wrestled with a big problem, and came out on top. R. B. Lourie's local arrangements committee undertook a tremendous task, and came through with a smile.

An unofficial advance guard to the main body, rural electrification men arrived for a Friday and Saturday confab of the rural electric project leaders. Extension agricultural engineers established a march outpost at Urbana, Illinois, June 12, 13 and 14; made their estimate of the situation; and invaded Moline from the right flank on Sunday, June 15, reconnoitering the Caterpillar entrenchment at Peoria en route.

News spread a few days prior to the meeting to the effect that C. F. Kettering, the "Will Rogers" of engineering research, would speak on Monday rather than on Tuesday morning, resulted in the Monday morning session of the College Division being largely attended by the industrial and other non-college groups. With this large and influential audience lured within earshot, Division Chairman Jones' academic speakers expounded fluently from well-prepared papers.

"The last thing a researcher needs is a laboratory," said Mr. Kettering. "Real research is done in the head, not in a laboratory." Agricultural engineers with wits sharpened by years of work with meager facilities keenly appreciated the subtle compliment and applauded roundly. E. S. Patch and J. H. Davis earned the sincere thanks of the Society for their important influence in inducing their busy "boss" in General Motors to accept a place on the program.

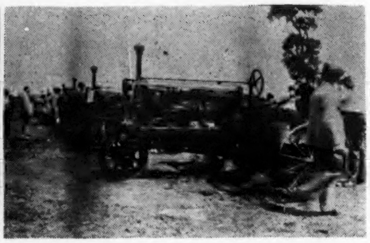
A particularly loud and prolonged burst of applause echoed through the corridors of the Elks' Club Tuesday morning, when Dr. A. F. Woods, director of scientific work of the U. S. Department of Agriculture, assured the audience that a bureau of agricultural engineering would be provided for in a pending reorganization of government engineering work, if not sooner. This was one of several remarks Dr. Woods made aside from his paper which gave conclusive evidence of his appreciation of the importance and opportunity for agricultural engineering research.

The general sessions were notable for the number of men who showed an intense interest in the papers presented. President Kaiser outlined the progress of the year; President-elect Trullinger expounded on agricultural engineering research; H. B. Walker came east from California with new viewpoints on tillage research; Dr. R. A. Clemen reviewed the rapidly developing chemistry and economics of industrial utilization of agricultural products, by-products and wastes, calling attention to the place of agricultural engineers in this branch of progress; F. A. Wirt's illustrated lecture, on the "Influence of Farm Machinery on the Development of America" offered an interesting "before and after" study with bouquets for engineers; and Wheeler McMillen propounded some of his typical thought-provoking ideas on the future of agriculture and agricultural engineering. G. W. McCuen directed his contingent of practical and scientific tractor corn growers, including Ira C. Marshall (world's champion corn grower), R. H. Wileman, R. I. Shawl and E. M. Mervine, to an oral victory over any "doubting Thomas" who might dare to question the advisability of their methods.

Before closing the Thursday morning session President Kaiser called the new officers of the Society to their feet for a round of applause and turned the gavel over to President Trullinger, who called upon the members to stick by him through the trials and tribulations of the coming year.

L. J. Fletcher, as master of ceremonies, engineered a speechless annual banquet which outdid all previous banquet successes of the Society. Agricultural engineers furnished most of the talent. H. M. Railsback favored the Society with some of his poems of rural life, presenting them through a dialogue, entitled "Contentment," in which an old couple grown rich in the simple, lasting joys of farm life reviewed together their lives and the book of poems they had learned to love. Orchestra music

The wives and children of agricultural engineers who came with them to enjoy the hospitality of Moline

General-purpose tractors, with associated implements, lined up for inspection at the demonstration farms

and vocal and accordian solos were other features of the program.

Progressing from the sublime to the ridiculous, an "Agricultural Engineering Follies" presenting take-offs on prominent agricultural engineers and features of the meeting brought the banquet to a close with everyone in high spirits.

H. E. McCray, W. Leland Zink and their following of power take-off standardizers won the leather metal for consistent early rising. So full was the program that the only time available for this group to do business was between sunrise and 9:30 a.m., the starting time of the regular meetings. Monday they started at 8:00 a.m. but were just getting nicely warmed up when it was time to adjourn. Tuesday and Wednesday mornings they gathered on the roof garden for seven o'clock breakfast meetings and for Thursday morning they moved the time ahead to 6:30. When they failed to finish their work that morning they resolved to stay as long the next day as might be necessary. In a 7 to 12 session Friday morning they reached an agreement upon the last points of contention. As a result of their deliberations the engineers of the leading farm machinery manufacturers are much closer than ever before to an understanding which will greatly increase the effectiveness of power take-off standardization.

The A.S.A.E. Council held its business meeting on Monday evening and the extension agricultural engineers and agricultural engineering students each held meetings at the same time to consider their special problems. On Tuesday evening there was a larger attendance than usual at the annual business meeting of the Society, and at the separate technical division meetings which followed. At the business meeting J. B. Davidson told something of the preliminary plans for entertaining the Society at Ames next June. H. B. Walker gave an interesting report on the World's Engineering Congress at Tokio last fall, at which he represented the Society.

In addition to these and other reports there was an important proposition brought up by George W. Kable. He offered the novel suggestion that the Society suspend publication of its "Transactions" and divert the money saved to committee work. The discussion which followed amounted to a testimony meeting on the value of the Transactions, and it soon became evident that the Society is not yet ready to sacrifice this volume on the altar of committee work.

The technical divisions discussed their winter meeting programs. A call by Chairman Blasingame for suggestions on next winter's Power and Machinery Division program brought to light enough subjects demanding attention to keep the Division in continuous session for a week. The difficult task of selecting the most important and developing a two-day program which will not be too crowded was left to the incoming chairman, H.E. McCray.

Jupiter Pluvius took a hand in the afternoon programs, sending a record rain Saturday evening which turned demonstration fields into a sea of mud and necessitated delaying the field demonstrations until Wednesday and Thursday, Monday and Tuesday afternoons being given to factory inspection trips. For these afternoon events the crowd was split into two sections which took turns visiting the John Deere and International Harvester factories and demonstration farms. The mechanics of dividing the visitors so that each one would have a chance to see everything was nicely worked out in advance, being reduced to a simple matter of red and green books of numbered tickets handed out at the registration desk. Drivers of the chartered busses took up the ticket stubs and eliminated all possibility of anyone going on the same trip twice by mistake.

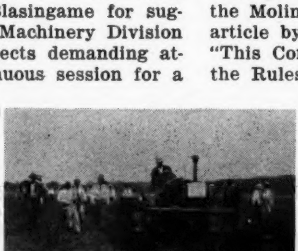
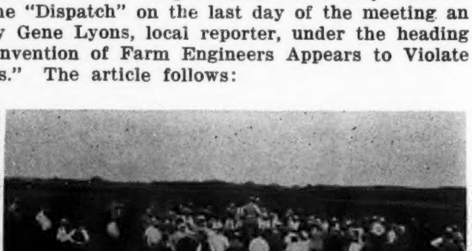
The time available was far too short to enable the engineers to fully satisfy their curiosities in going through the "Farmall" and John Deere factories, but all saw many stages and processes in the gradual shaping of tractors and other implements from the pouring of molten metal to running the completed machines off the assembly line.

Upon arriving at the demonstration farms visited the first thing to do was to eat a big free lunch. Agricultural engineers who were there know that the dining service at those farms far excels that on the roof garden at the Le Claire Hotel.

General-purpose tractors with a complete line of their associated implements were featured at the field demonstrations. They were shown in operation as far as possible. Plows plowed, harrows harrowed, planters planted, and cultivators cultivated. Hay was both mowed and raked. Even a duster belched its white cloud over imaginary rows of cotton. The cotton stripper, however, was stumped for lack of material to work on. Operation of the new machines was explained in an engineering way.

Case and Caterpillar engineers, at a disadvantage in not having factories in or near Moline, but not to be outdone in showmanship, arranged trips to their respective plants immediately following the meeting.

One of the important benefits of the meeting was the impression the Society made in the implement cities as a group of purposeful men with important work to do. Society members felt complimented when they read in the Moline "Dispatch" on the last day of the meeting an article by Gene Lyons, local reporter, under the heading "This Convention of Farm Engineers Appears to Violate the Rules." The article follows:

(Right) Two-row corn cultivating equipment being demonstrated. (Extreme right) Listening to an explanation of the engineering features of some of the new equipment

"What sort of fellows are these engineers, anyway?

"That is the question a lot of Moline residents are asking today as one of the most unusual conventions that the community has ever entertained—that of the American Society of Agricultural Engineers—draws to a close.

"Among the most mystified are the hotel employees who have observed that there is virtually no drinking going on and no parties. Moline's rather numerous "soft drink" parlors are reported to have been accorded scant patronage, despite the fact that there are some 500 or 600 men gathered in the city from all parts of the United States.

"That fact alone, some convention experts appear to think, would stamp this convention as extraordinary.

"Of course, there are men of national and international prominence among the delegates. But Moline has entertained such men before, and conventions have usually proved to be and escape from home "where nobody knows us" and the occasion for two or three days of hilarious good time.

"There is a business-like air about the entire procedure that in general is conspicuous for its absence in large meetings. A visit to a few of the sessions of the society brings to light more peculiarities.

"In the first place, when the program says a session starts at 9 a.m., the session starts at 9 a.m., not 9:30 or 10 as has been customary for the great majority of conventions which Moline has entertained.

"The large number of the delegates who are puffing at pipes almost continually is another striking feature of the meetings . . . .

"The attendance at the sessions, despite the fact that all of them are being held in the morning, is almost 100 per cent, another remarkable feature.

"Then there is the strict attention paid to the speakers—most of the delegates even takes notes a part of the time. The visitors seem to be in Moline very definitely to get something out of the convention. There is no straying from the subject during addresses to tell funny stories that most of the audience has probably already heard.

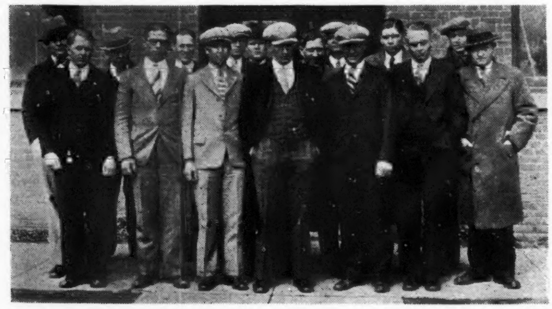
"Reliable reports indicate that approximately $10,000 was spent by the various committees which arranged the program. Part of this is, of course, returned through the $2 registration fee.

"The addresses, or rather papers, have been presented by men of recognized authority on their subjects. In fact America's leading agricultural engineers have spent the last four days in Moline.

"When they leave tonight, Moline can indeed boast of having played host to a most remarkable gathering."

American Engineering Council

THE engineering experiment station bill backed by the Land Grant College Association and supported by Council has been favorably reported from the House committee on agriculture and is expected to pass in the next session of Congress. As it stands this bill provides for federal support of the state engineering experiment station work to a maximum of $25,000 per station, per year, every federal dollar to be matched by three state dollars to be used for like periods and purposes. Provision for administration by the Secretary of Agriculture insures that funds would in fact be available for agricultural engineering research. Supervision and checks to insure coordination and prevent needless duplication are provided for.



These students at South Dakota State College recently petitioned A.S.A.E. Council for recognition as a student branch of the Society. They represent mostly a large class of freshmen in the professional agricultural engineering course. Their petition has been granted

Seven years of effort by engineers to induce Congress to provide the United States with a national hydraulic laboratory were recently climaxed by the signing of a bill appropriating $350,000 for the construction and equipping of such a laboratory in the Bureau of Standards. Whe in operation it will be available, subject to regulations, for the study of fundamental hydraulic engineering problems of federal, state and local government departments. Director Burgess of the Bureau of Standards is anxious to provide the best laboratory possible with the funds available and toward this end has requested the organization of a representative advisory committee. Council has been asked to suggest several names for members of this committee.

Upon recommendation of the oBulder Dam Consulting Board, Dr. Elwood Mead, U. S. Commissioner of Reclamation, has initiated a study of cracks in dams. It is believed that this work will produce valuable knowledge of safety of dam construction.

At the spring meeting of Council's Administrative Board attended by William Boss, representative of the A.S.A.E., reports of the committee on airports, patents and flood control, and routine reports of officers and executive committes were received and acted upon

Council's committee on reforestation, of which William Boss is chairman, has recommended support for the following bills:

H. R. 3245—Englebright—Authorizing appropriations for the construction and maintenance of improvements necessary for protection of national forests from fire.

H. R. 6981—Nolan—To promote the better protection and highest public use of the lands of the United States and adjacent lands and waters in Northern Minnesota.

H. R. 10877—Authorizing appropriations to be expended under the provisions of sections 4 to 14 of the Act of March 1, 1911, entitled: "An Act to enable any state to cooperate with any other state or states or with the United States, for the protection of he waersheds of navigable streams and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability rivers," as amended.

S. 3531—A bill authorizing the Secretary of Agriculture to enlarge tree planting operations in national forests east of the Rocky Mountains.

The Committee's report and its recommendations were in each case approved.

President Grunsky is considering the selection of personnel for a committee to confer with Weather Bureau officials on means of increasing the usefulness of the Bureau to engineers. This is in response to numerous suggestions received by Council.

Congressman Griffin has introduced a bill providing for medals of honor and the award of a stipend of $100 to $500, exclusive of salaries or pensions, to government employees for distinkuished work in science. According to the provisions Council, The National Academy of Sciences, and the American Association for the Advancement of Science would each appoint a representative to a commission to select candidates and recommendtheir names to the President. Council approved the bill in principle with the suggestion that the number of recipients be limited to two per year rather than five as the bill reads at present.

Correction

ERRORS which occurred on the "Who's Who in Agricultural Engineering" page of our May issue are hereby corrected as follows: E. B. Doran took his undergraduate work at the University of Illinois under Fred R. Crane and C. A. Cook, rather than under E. A. White as stated. He became a member of the Society in 1914 and while taking advanced work at the University of Illinois in 1928-29 served part time as associate professor in the department of farm mechanics.

Personals of A.S.A.E. Members

J. K. Alvis of the Caterpillar Tractor Company and **V. R. Hillman** of the department of agricultural engineering at Virginia Polytechnic Institute were awarded their master's degrees in agricultural engineering in the spring graduation at that institution.

F. C. Fenton, professor and head of the department of agricultural engineering at Kansas State Agricultural College was recently awarded his master's degree in agricultural engineering at Iowa State College.

Henry Giese of the Iowa Agricultural Experiment Station and director of the U.S.D.A. investigation of research in farm structures received his A. E. degree at Iowa State College in June.

E. R. Gross, professor and head of the department of agricultural engineering at Rutgers University, and **W. C. Harrington,** agricultural engineer, Portland Cement Association, are planning to spend a few weeks together in Europe this summer. They will sail from Quebec, Canada, on July 23 and expect to see some of France, Belgium, Germany, Switzerland and possibly Italy. They will also attend the International Congress of Agricultural Engineering at Liege, Belgium, where they are scheduled to present papers. The subject of Mr. Gross' paper is "Spraying Fruit Trees from Stationary Plants."

H. B. Josephson, research agricultural engineer, Pennsylvania State College, sailed early in June for Europe where he will travel and study agricultural engineering during the summer. He will contribute a paper to the International Congress of Agricultural Engineering and will also act as the official representative of the American Society of Agricultural Engineers at the Congress.

J. W. Pincus is leaving for Europe this month. While there he will attend the International Soil Congress which will be held in Leningrad and Moscow from July 22 to August 1. After that he will visit some of the agricultural institutions in Russia before returning to his business in New York.

P. B. Potter of the department of agricultural engineering, received his A. E. degree in June from Kansas State Agricultural College.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

B. O. Childs, assistant agricultural engineer, U. S. Department of Agriculture, Houma, La.

W. N. Danner, Jr., adjunct professor, Georga State College, Athens, Ga.

G. N. Denike, assistant superintendent, Dominion Experimental Station, Swift Current, Sask., Can.

Victor Etem, salesman, Wm. H. Ziegler Co., Inc., Minneapolis, Minn.

R. E. Everett, experimental engineer, John Deere Plow Works, Moline, Ill.

K. H. Gorham, advertising manager, "Electricity on the Farm," New York, N. Y.

Charles Hollerith, secretary and general manager, Automotive Fan & Bearing Co., Jackson, Mich.

Louis Jacobi, engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

J. G. Kimmel, civil engineer, Palmer Corporation, Sarasota, Fla.

C. C. MacMillan, sales department, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Osgood Murdock, editor, "Implement Record," San Francisco, Calif.

J. E. Newman, research worker, Institute for Research in Agricultural Engineering, University of Oxford, Oxfordshire, England.

F. L. Rimbach, rural development agent, New England Power Association, Worcester, Mass.

J. O. Smith, agricultural engineer, Delta Experiment Station, Stoneville, Miss.

S. C. Thayer, farm manager and operator, Akron, Ohio.

Transfer of Grade

G. A. Cumings, agricultural engineer, Bureau of Public Roads, U. S. Department of Agriculture, Washington, D. C. (Associate Member to Member.)

New A.S.A.E. Members

Franklin D. Fulton, assistant agricultural engineer, U. S. Department of Agriculture, Toledo, O.

W. F. Heesch, general manager, French & Hecht, Inc., Davenport, Ia.

C. N. Hinkle, instructor, Purdue University, Lafayette, Ind.

Ivan A. Karmanoff, mechanical engineer, Amtorg Trading Corp., New York, N. Y.

Lamar M. Kishlar, consulting engineer, Ralston Purina Co., St. Louis, Mo.

C. H. Moran, sale promotion manager, Westinghouse Elec. & Mfg. Company, East Pittsburgh, Pa.

Vernon E. Parrish, orchardist, Box 33, Cupertino, Calif.

George O. Sanford, reclamation economist, Bureau of Reclamation, Washington, D. C.

Harry W. Trump, sales engineer, Timken Roller Bearing Co., Canton, O.

Edward T. Wilson, agricultural engineer, Pennsylvania Power and Light Company, Allentown, Pa.

Transfer of Grade

J. W. Slosser, special salesman, John Deere Plow Co., Kansas City, Mo. (Student to Junior Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Positions Open

AGRICULTURAL ENGINEER wanted to fill position as instructor or assistant professor in the department of agricultural engineering of one of the land grant colleges of the Northwest. A recent graduate in agricultural engineering qualified for rural electrification and power farming with farm and practical experience is desired. Opportunity offered for research work and for participation in experiment station and extension service projects. Teaching work required will be largely in service courses in agricultural engineering. Minimum salary \$1800 to \$2100 per year on twelve months basis with one month vacation. PO-155.